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THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW

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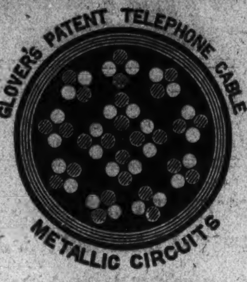

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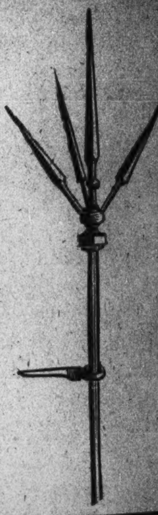

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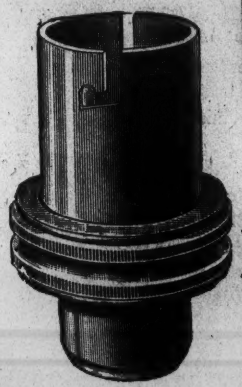

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SPECIFICATION OF INSULATED CONDUCTORS.

The paper read by Mr. Preece last week before the Institution of Electrical Engineers, and reprinted in our columns, calls attention to a subject which has been to a great extent neglected by the users of insulated conductors for electric lighting; and we hope that the paper itself and the discussion, which will take place in the early part of next year, will be productive of good results, by calling attention to the importance, not only of a careful choice of this class of cable, but also of ascertaining that the cable supplied fulfils in all respects the specification to which it was ordered.

Mr. Preece finds fault with the electric light engineer, because he has followed the practice of the submarine cable engineer in specifying that cables shall have an insulation resistance of so many megohms per mile, a mode of specifying which he points out is, owing to the many dimensions in which electric light cables are made, meaningless and wrong for the latter; we think also that the fault to a great extent lies in the fact that another practice of the submarine cable engineer is not followed, since cables are only too frequently used for which no insulation resistance is asked for or guaranteed, or if a resistance is specified, no mention is made of the conditions under which the test is to be taken; and, most important of all, no attempt is made to ascertain that the cable comes up to specification. The case to which Mr. Preece refers in his paper as having recently come before the law courts, is an example of this, as it would probably not have come there at all if the practice of the submarine cable engineer had been followed; we think, therefore, that instead of complaining of them, every encouragement should be given to those electric light engineers who have specified for a definite insulation resistance, and have taken the trouble to satisfy themselves that this resistance is obtained when the cable is tested in water under the conditions named by them.

In connection with this subject of testing, it is well that attention should be drawn to the importance of clearly stating the conditions under which the test is to be made, and if the paper which has just been read will induce electric light engineers to be more particular in this respect it will have done an excellent work. In many specifications which we have seen, although a resistance of so many megohms per mile is specified for, no mention is made of the time the cable is to be immersed before being tested, or of the temperature of the water, and nothing is said about the duration of the electrification before the test is made. In such a case the specification deserves to be called meaningless, as it is well known to those who have practical experience in testing that the resistance of some dielectrics may be doubled by lowering the temperature, say, 15° or 20° Fahr., or by calculating it from the deflection obtained after three or four minutes, instead of after one minute's electrification.

Although we lay, and always have laid, great stress on the value of the insulation test, we agree with Mr. Preece that it is not the only thing to be considered, the durability and mechanical strength of the insulating material being in many cases of greater importance than its specific resistance. How to specify for these qualities has always been the difficulty, and we regret that the paper before us does not give any information on this subject, but deals only with the insulating quality of the material, and the thickness required to resist the potential differences employed. As regards the method of specifying insulations, the advantage of adopting a specific unit is so obvious that the only wonder is that it has not come into use before; the more it is used the more comprehensible it will become and the more, we think, it will be liked. At first the real meaning will not be grasped but experience will soon make it clear.

In specifying the thickness of dielectric which should be used, it would appear from the paper that Mr. Preece would make no difference between the various materials which are employed for insulating conductors, and, further, that he considers that a covering one millimetre thick makes an equally efficient cable, whether the diameter of the conductor is one or ten millimetres. We shall expect to hear both these points strongly combatted in the discussion, as many manufacturers and users of cables will doubtlesss bring forward reasons, rightly or wrongly, to show that any such assumptions cannot, in their opinion, readily be accepted.

In conclusion, we would refer to a matter in which we consider that Mr. Preece is rather hard on the manufacturers, when he refers to the abuse of ordinary precautions which is encouraged by the manufacture of cheap and nasty cables. We believe it is only fair to the manufacturers to give them a very large portion of the credit of having raised the standard of quality for all electric light cables, and when we consider the number of contractors who still will not buy the better qualities of cables, we can hardly blame the manufacturer for supplying those for which there is a demand.

THE LONDON OVERHEAD WIRES ACT.

THE draft bye-laws for the regulation of overhead wires, which were submitted by the Highways Committee to the London County Council at their meeting last week, and were approved by them, have yet to be submitted for approval to the Board of Trade; and it would be well, therefore, for engineers interested in this matter to obtain copies and to determine at once whether there are any points in them to which objection should be raised. The majority of the regulations appear to us to be unobjectionable, since they are intended merely to systematise the erection of overhead wires, and do not introduce any restrictions which will bear hardly on engineers or contractors whose business it is to erect and maintain such wires. We notice, however, that Section 8 specifies a factor of safety of 5 for all conductors and suspending wires, and of 10 for all other parts of the structures, taking the maximum possible wind pressure at 50 lbs. per square foot. This is, except for the slight reduction in the factor of safety, a reproduction of the Board of Trade rule, to which we have referred on several occasions in these columns, and is, we consider, unnecessarily stringent, as lines calculated for much smaller strains have been in use for years without failing. Another section which may bear hardly on the telephone companies is that which says that no wire or support shall remain erected for more than one month after it has ceased to be in use, unless the company owning it intends to use it again within three months and gives notice of such intention. Every change of tenancy may, under this rule, necessitate the removal of an existing wire, or the re-erection of a new one, and we think, therefore, that the clause might be modified so as to extend the time during which the wire may remain out of use; of course, on the understanding that it is maintained in as good working order during such time as if it were a "live" wire. Taken as a whole, these regulations should, if judiciously enforced, bring about an improvement in the condition of our overhead network; more especially if care is taken to carry out the regulations as to maintenance; as, if this is done, it will then be so much to everybody's interest that the work should be good in the first place, that there will be very little need for stringent regulations about wind-pressures.

PATTEN'S NEW ELECTRO-MOTOR.

IN this motor, the invention of Lieut. Patten, the armature is energised by two pulsating intermittent currents derived from an alternating current by a rectifying commutator; this commutator splits the alternating current into its two component parts, sending all the positive impulses into one circuit on the armature, and all the negative impulses into the other circuit, the armature being a Gramme ring with double winding.

This pulsating current has not been found suitable for exciting the field magnets, so the inventor proposes to use a storage battery charged by the pulsating current, for the purpose of steadily exciting the field magnets.

It may be possible to charge a battery with the uni-direction pulsating current derived by rectifying an alternating current, but there are certain very obvious difficulties which are not explained away in the accounts given of this motor; the first difficulty is the discharging back of the battery during the interval between the impulses of the current. The back or counter E.M.F. of the battery is steady, while the pulsating E.M.F. is fluctuating between zero and a maximum.

The battery being charged, can receive charge during the short period when the pulsating E.M.F. is higher than the counter E.M.F. of the battery, and a discharge must occur during the period when the counter E.M.F. is greater than the pulsating E.M.F., and any charge gained by the battery must be due to the time of the charging period being greater than the time of discharge; moreover, there is evidently a considerable loss in charging a battery with a pulsating current of this kind.

Two alternating currents in quadrature, when rectified and put in series through a battery, can effect a steady charge, because there is no zero in the fluctuations; the one impulse is at a maximum during the time that the other is at zero, hence the charging E.M.F. never falls below the counter E.M.F. of the battery; but this plan is not contemplated by Patten.

The motor is interesting as an attempt to solve the apparently insolvable problems in producing a motor which can be worked on a simple alternating current system.

The multiplicity of parts is objectionable in this motor: besides the motor there is the rectifying commutator with four brushes, and an ordinary Gramme ring commutator with two brushes, two storage batteries with double-pole switches, and other gear.

Alternate Current Motor Working.

THE *Bristol Mercury* states that a correspondent noticing the care with which the Bristol Committee have set about selecting their electrical lighting plant, says:—"It is well known that a central station which is able to supply current for motive power as well as for lighting purposes is at a great advantage over one which is able to supply current for lighting only. Because in the daytime when only few, if any, lights are required, the machinery can be kept running to supply electromotors for the thousand and one uses to which they can be put. Thus, without any more capital outlay, the 'earning' capacity of the station may be practically doubled. The system to be adopted in Bristol is the 'alternating current' one, and it is only recently that a practical self-starting motor has been available which would work with such currents. This coupled with the invention of the 'Rotary,' or 'Three Phase' current system, so prominently brought forward at the late Frankfort Exhibition, has practically solved the problem of alternating current motor working. The Electrical Committee of the Town Council will therefore do well before placing their contracts for machinery, &c., to have this point thoroughly discussed with their technical adviser. For, as alternating current dynamos of the ordinary type are not suitable for efficiently working motors, but only for lighting, and as alternating current dynamos on the 'Three Phase' system are equally well adapted for both motors and lighting, it is most desirable that no mistake should be made in selecting the plant. Electromotors worked by alternating currents have enormous advantages over those worked by direct current, as they can be made without commutator brushes or moving contacts of any kind, and therefore give no trouble from sparking." We fear that the correspondent to the *Bristol Mercury* has not followed the technical literature on this subject very closely or he would scarcely have advocated the adoption of the "drehstrom" method of actuating motors. Of this he may be assured that the technical adviser to the Corporation will not need to think twice before rejecting such a proposal. He should read the series of papers running in the REVIEW on "Polyphased Alternate Currents," and the article in our last issue on the Lauffen-Frankfort experiments.

Electric Girls and Magnetic Ladies.

THE paper on the magnetic lady which we publish in our other columns will be read with considerable interest by those who have heard of or witnessed the performances of Miss Annie Abbott at the Alhambra. Mr. John Verity will no doubt feel inclined to include it in the next edition of "Electricity up to Date," and Mr. Shippey, "the well known scientist in electrical circles," will see that his classical "thermo-polaic" theory is not required to explain the "little Georgia Magnet's" seemingly impossible feats. Mr. Nelson Perry, however, does not quite seem to have grasped our real meaning with regard to the mention of electro-magnetism in assisting so-called strong men or women to carry out their stage tricks in lifting apparently enormous weights. Naturally the simple methods adopted of impressing a gullible public with wonderment at the marvellous development of muscular power, is not common knowledge, but what was running in our minds when penning that remark, which has made Mr. Perry sad, was a dodge sometimes practised by would be Samsons. The curtain rises and two enormous dumbbells are seen standing on the stage; their stated weight is so great that it at once becomes apparent to the audience they must be of solid iron. The strong man takes his stand between them, and, striking some impressive attitudes, he succeeds by fearful strainings and contortions in lifting the weights some distance from the stage floor. Any of the awe-stricken lookers on are then invited to try their strength, and perhaps one really strong and bold man will step upon the stage and essay the same feat. Strive as he will, he cannot make the dumbbells leave the floor; not even one of them will budge an inch if he exerts all his strength upon it. The "professor" comes forward again, and smilingly repeats his previous performance with apparently greater ease than before. The secret of the mystery is that the weights are of wood or hollow metal, say iron, and having an iron base, and under the stage is a powerful electro-magnet with its pole pieces coming through the stage, flush with the floor, and painted to represent wood. The weights are placed on these pole pieces, and the electro-magnet circuit is broken or closed by the professor or his assistant, according to whether he himself or the dupe from the audience is manipulating the apparatus. Mr. Perry will now probably allow that we were justified in saying that we could understand how electro-magnetism might be utilised in lifting or non-lifting experiments.

The *Lancet* and Electrocution.

OUR contemporary, the *Lancet*, has taken many weeks in considering what reply to make to our strictures upon its attitude towards electrocution. Its issue for December 12th, contains a feeble protest against our own criticisms as well as those of some of the French electrical journals. We are taken to task for our "singular ignorance" of English law and it is stated that we have affirmed that the medical man in England "takes equal part in the executions by hangings which are carried out in our prisons." Will our contemporary acquaint us with the date of issue, page and line, in which we "affirmed" any such thing; what we stated was that the medical officer was present in his official capacity to watch the proceedings and we never even implied that any surgeon in the prisons of this country "takes any part in an execution or gives a hand of any kind to the hangman." But our remonstrance with the tone adopted by the *Lancet* seems to have had some effect; there is a marked moderation in its reference to the last electrocution at Sing-Sing prison, New York. The tone is very different to that adopted on October 24th, and the significant statement is made that "death in this case is reported to have been painless, and we have no doubt on that point"; we are glad to make a note of this. Our contemporary, however, feels bound to put in a "Parthian arrow." It says "one of our great London antiquaries has a collection of pictures showing the various kinds of punishment inflicted on offenders against human law in the still barbarous days of last century," and sighs when it reflects "what an addition this century will render to such a collection, with electrocution towards the close of the century as the last accomplishment!" We admit such a collection with the latest addition would be gruesome enough, but we question whether it would be so horrible as a series of photographs illustrating the protracted sufferings of the unfortunate animals that are "experimented upon" in the laboratories of the licensed vivisectionist, or even as the lantern display reported on p. 1,322 of this week's *Lancet*, in which the effects of inducing tubercular meningitis on some unhappy guinea pigs were exhibited. We question whether even a Tussaud would care to include such a series of horrors amongst his collection.

THE ELECTRICITY BUILDING AT THE CHICAGO EXHIBITION.

WE extract Section 8 of Mr. James Dredge's paper, read before the Society of Arts, from the society's journal :—

THE ELECTRICITY BUILDING.

The Electricity Building covers an area of 250,000 square feet, and is estimated to cost $130,000. The architects are Messrs. Van Blunt and Howe, of Kansas City, and the design appears not only admirably adapted for its purpose but sufficiently well proportioned and ornamental to take a front rank among the many splendid buildings on Jackson Park. The main entrance to the building faces on the great central avenue, near the Administration Building. The principal architectural feature at this end of the building is a portico and colonnade, extending for the whole width on each side of the monumental entrance, over which are inscribed a series of names famous in the annals of electrical science. The main tower at this end reaches an elevation of about 200 feet, those at the sides being somewhat shorter and of more slender proportion. Except for the two large bays at the back of the building, the plan is rectangular, the length being 690 feet, and the width 345 feet. The centre of the building is occupied by a large hall, running from end to end, and about 115 feet span, flanked by a double row of columns and aisles 70 feet in width. Important entrances will occupy the centre of the building on each side, and access is gained to the galleries by broad stairways occupying the middle of the building. The end bays will be glazed so as to afford as much light as possible. Large as are the dimensions of this building, it may be confidently expected that they will be insufficient to accommodate the exhibit. Electricity and its practical applications will be one of the largest and most important sections of the Exhibition, and during the next two years there will, doubtless, be many new developments not yet brought into a practical form. In connection with this building, some general particulars of the scheme of electric lighting at Jackson Park may be given. The plans have been elaborated by the chief electrical engineer, Mr. Sergeant, and his proposals have been accepted by the committees on electricity, on the grounds and buildings; and by Mr. Burnham, the chief of construction. As upon every other point, so in this matter of illuminations, the executive appear determined to surpass all that has been hitherto attempted in this direction at international exhibitions. In 1889 only three of the main buildings were opened at night to the public and furnished with electric light. It has now been decided that complete arrangements shall be made for lighting every one of the great halls at Jackson Park as well as the extensive grounds. The scheme elaborated up to date refers to nine of the great buildings, and comprises 5,180 arc lamps of 2,000 candle-power each, and 14,700 incandescent lamps of 16 candles. Except in the Fine Arts, the Administration, and the Women's Buildings, arc lights will be employed and will be distributed as follows :—In the Machinery Hall there will be 600; in the Agricultural Hall, 600; in the Electric Building, 400; in the Mines and Mining Building, 400; in the Transportation Building, 450; in the Horticultural Hall, 400; in the Forestry Building, 150; and in the Industrial Arts Building, 2,000. As just stated, there will be no arc lights employed in the Fine Arts Buildings, but in their place the interior will be lighted by 12,000 incandescent lamps. The Administration Building will be illuminated in the same manner, and about 12,000 16-candle lamps will be required for this purpose. The lighting of the Women's Building will be mixed, and comprise 180 arc lamps and 2,700 incandescent lamps. In addition to the lighting supplied by the authorities, any exhibitor who requires it will be able to obtain current for lighting his display in any manner he thinks fit, conformably with the lighting regulations. It is presumed that this current will be furnished to private consumers at a fixed and very moderate tariff. The arrangements for lighting the grounds, for the illuminated fountains, for private lighting, and miscellaneous purposes, have not yet been completed. It is decided in principle, however, that every one of the numerous pavilions and official buildings will be abundantly supplied with electricity, so that any reasonable amount of light can be obtained, and gas will be practically, if not actually, unknown at Jackson Park as an illuminant. It is intended, amongst other novel applications of the electric light, to illuminate the harbour enclosed within the pier and breakwater, already referred to, either wholly or in part, with submerged incandescent lamps so arranged that the light may be thrown upwards towards the surface of the water. Such an arrangement would undoubtedly consume a large amount of power, but the effect would be very striking and attractive.

It should be mentioned that already a large amount of electric power is available on the grounds, an extensive installation having been completed and put in operation. It has been ordered by the executive that the contractors are not to be allowed to use steam power, but that they must work all their machinery by electricity; this has been done to reduce the risk of fire during the progress of the work. All the sawmills set up for the industrial building are driven by this means, and the contractors for the administration and horticultural buildings are already using a considerable amount of the same power. There are at the present time at least a dozen motors driven by current furnished from the temporary central station. This is an entirely novel application of electricity in connection with exhibition buildings.

A very considerable amount of current will also be required for lighting the grounds through the long winter nights, during which work will be carried on continuously by different shifts of men. The arrangements made between the executive and the directors of the labour unions limit the length of daily work to eight hours. By this means the executive is confident that they will carry the work forward to its conclusion, without any interruption due to labour troubles.

THE DYNAMOS AT FRANKFORT EXHIBITION.

By W. B. ESSON.

IX.

THE Frankfort Exhibition, now numbered with events of the past, has left an indelible mark upon the history of electrical progress. Exhibitions we have had before, but none of them has possessed for those engaged in heavy electrical engineering the peculiar interest of the Frankfort one, as at no previous time had there been a display of central station machines in any sense comparable with the collection that exhibition brought together. And most of us will admit that there was something to be learnt at Frankfort, as there is at most great shows. It is impossible to visit such an exhibition with one's eyes open without coming away wealthier in ideas if not in pocket, while the knowledge gained is certain to prove useful some day, if not immediately, at any rate by-and-bye. The instruction derived is generally of two kinds, for we are very often taught what to avoid as well as what to adopt. But having an opportunity of comparing our own practice with that of our neighbours, after weighing all the facts and circumstances, our judgment should always be given fairly and without prejudice. Though in their equipment, arrangement and handling, the central stations of the Continent differ greatly from what we English engineers are accustomed to, they ought to receive no comprehensive condemnation on that account. It would be strange, indeed, if we had within the limits of the United Kingdom all the knowledge worth possessing, or if European practice as exemplified in the splendid stations of the Continent had nothing more to teach us.

In the preceding articles all machines of note have been described, and attention has been directed to several points of novelty in design and construction. A large amount of information has been given, and those interested in dynamos will know how to classify the data placed at their disposal should they consider this worth while. So far, then, the writer's task is at an end, and the mass of correspondence to which its execution gave rise having been duly pigeon-holed, it only remains for him to offer in this concluding article some observations on the machines generally.

Some of the peculiarities of German dynamos have been referred to as we have gone along. The practice of insulating the commutator segments in most instances by cardboard or fibre, has been mentioned, while the custom of attaching the conductors to the segments by screws has also been alluded to. These are matters of detail, however, and are not of the greatest importance; what we have to consider more particularly is the general drift of German practice as regards types, remembering that it is in Germany that the largest central station undertakings are to be found.

It will have been noticed that only in the smallest machines were the poles confined to two; for machines of any size, the multipolar design was invariably adopted. The largest two-pole machine was one of Siemens and Halske's (p. 343), giving 80 kilowatts at 550 revolutions, this output being quite exceptional, however, for a machine with two poles. Next came the Helios machine (p. 504), giving 44 kilowatts at 375 revolutions; and thirdly, that of Pokorny and Wittekind, giving 33 kilowatts at 600 revolutions, all being belt driven.

These were for isolated installations; for central stations the machines were direct coupled, and for driving them, double acting engines of the compound or triple condensing class were universally employed, generally of the inverted type. Continental practice presents, in this respect, a marked contrast to English methods, the dynamos in our stations being most frequently coupled to single acting high speed engines. Whether the latter type will prevail when machines of 500 or 600 H.P. come to be built here, is a moot point, but its discussion fortunately lies outside the limits of this article.

Leaving the method of driving, let us consider the dynamos themselves. Taking the drum machines first, we find that those exhibited were not of very large size. The Esslingen Company had a direct coupled eight-pole one, giving 60 kilowatts at 100 revolutions per minute, with a 114 cm. armature, while Lahmeyer, of Frankfort, had a four-pole belt driven one, giving 80 kilowatts at 350 revolutions, with a 60 cm. armature. These were the largest, but amongst the drums must also be included the three two-pole machines already mentioned. Curiously enough, all the drums in the exhibition—those of Esslingen and Siemens and Halske excepted—had their conductors lying in Pacinotti slots, just like the Weston machine of 10 years ago.

But, with one exception, the magnets of all the machines having drum armatures were of cast iron, and this has a rather important bearing upon the question of heating. It is well known that if the armature is to have Pacinotti projections, in order that heating of the poles may be avoided, a certain amount of clearance must be given between the projecting teeth and the pole surface, depending upon the width of the slots in which the conductors lie. In some articles written in 1885,* the writer pointed out that when the clearance was equal to ·35 of the width of the slot there was no perceptible heating of the pole-pieces, while by making the slots sufficiently numerous the clearance might be diminished until its further reduction would be undesirable, owing to the necessity for mechanical clearance and immunity from sparking. Now, this clearance was for machines having the armatures rotating in the cavity formed by boring out wrought iron magnet bars, but since the conductivity of cast iron, as measured by Hopkinson, is only about one-tenth that of wrought iron, when poles of the former material are employed the tendency to heat is very much reduced, and the clearance may be diminished without any damage resulting. In the articles referred to, it was stated that the advantage to be derived from the Pacinotti armature was a reduction of about 30 per cent. in the resistance of the air gap; but if sparking does not come in, obviously, the advantage may be considerably increased by using cast iron magnets, on account of the reduced clearance. With this reduced clearance, however, the machines, when of large size, must have four or more poles, as with two only the tendency to sparking would fix a larger clearance than would the tendency to heating of the pole-pieces. With the multipolar field the advantage of a diminished gap resistance may be obtained without incurring any risk of sparking, and it is not surprising to find, therefore, that large drum machines with Pacinotti projections and cast iron fields run very satisfactorily.

It should be remembered that the wire winding of multipolar drums can be done most conveniently in slots, whereas if a bar winding is needed, the bars can be solid without any trouble arising due to the generation of parasitic currents in them. There were no drum armatures with bar windings to be seen, but to some extent this is accounted for by the fact that the few large drums exhibited were wound for high potential. Had the voltage for either of these been 120, a bar winding of some sort would have been, no doubt, employed.

Coming to the Gramme-wound machines, we can no longer confess disappointment as regards dimensions. As a matter of fact, so far as numbers were concerned, the machines were pretty fairly divided between drum and ring types, but, as regards size, the latter greatly transcended the former. The two-pole machines call for no remarks other than those to be found in the descriptions already given; they were few in number, and of small size. But the multipolar Gramme machines deserve special attention, for they certainly constituted, after the Lauffen-Frankfort experiment, the chief feature of the exhibition. With one exception, as in the drum machines, all the field magnets were of cast iron, and the ruling type, as will have been evident from preceding articles, was that in which the poles are inside the armature.

There has been urged against multipolar Gramme machines the objection that since the current flows in several parallels, consequent on any difference in the E.M.Fs. generated under the separate pole shoes, there may be caused considerable loss from local currents, or, to put it in another way, the current distribution in the several parallels may be unequal, thus increasing the armature loss. The same objection might be urged against drum machines were it customary to connect these up in as many parallels as there are poles, but fortunately, in the case of the latter, the remedy is simple. Suppose, for example, that we have a four-pole drum armature with half as many commutator segments as there are conductors. Coupled in four parallels we should, starting from one of the segments, first go down a bar under, say, a N pole, then come up another 90° round under a S pole, joining to the next commutator segment, and so on till the winding were completed. Now, if due to wear of the bearings the armature got out of centre, clearly unequal E.M.Fs. would be generated, and the four parallels being electrically unbalanced, a local current would be urged round the closed winding, thus wasting power. But instead of going only down a conductor under a N pole and up another under a S before going to the next commutator segment, let the current go through a bar under each of the four poles, flowing through the winding in two parallels instead of four. Here we get a perfectly balanced circuit, as the current between two adjacent commutator segments has to flow in series through four conductors under the four separate poles, and it does not matter if the armature is out of centre, since the bars having unequal E.M.Fs. generated in them are always in series. This is the mode of winding:—Starting from one of the commutator segments we go down a bar, say, under a N pole, then joining across the back we come up another bar 90° round the circumference under a S pole. We then join on to a commutator segment not adjacent to, but opposite the one we started from, and leaving that again, turn down a bar under a N pole 180° from the one we started with, joining across the back and coming up one under a S pole 90° farther on, or 270° from the first position. We then join on to the commutator segment adjacent to the one we started from, and going from that down the bar next but one from the starting bar we keep on round and round the armature, always in the same direction, till the winding closes. The closing number of bars for such a winding, or if coils are used the number of ends is $= 4\,n \pm 2$, where n is any odd number. The current is collected by two brushes placed 90° apart on the commutator, as in the machines of Lahmeyer, described in last article. The commutator segments are half the number of bars, so they are odd; for example, in a four-pole machine with 198 bars, there would be 99 segments, or in one with 222 bars there would be 111.

The above method of winding to balance the parallels, though almost universally adopted for multipolar drum machines, cannot be conveniently adopted for Gramme armatures, as a spider's web of connections going across the middle of the armature to couple balancing coils is out of the question, nor is an arrangement of the kind even possible with a heavy bar winding. Accordingly, it comes to this: if the difference in the E.M.Fs., due to the armature getting decentred through wear of the bearings, is such as to seriously reduce the efficiency, the Gramme machine as exemplified by interior pole types is bad, and some form must be adopted in which the induction in the air gaps is not altered by the armature getting a little out of centre. The flat ring machine of Schuckert is all right in the latter respect, but, unfortunately, having a bifurcated field where the lines of force from each pole take two paths through separate coils, the wire required on the magnets is much greater than is needed for radial magnets, where there is no bifurcation.

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* "Dynamo Armatures—II." The Electrical Review, Vol. xvii., page 406, November 14th, 1885.

Unfortunately, we have no figures before us relating to interior pole machines of large size, so we do not know their efficiency, nor can we do other than speculate as to the probable loss due to decentreing of the armature, should it occur. But one hopes that the effect will be inconsiderable, for once concede the point that the Gramme machine is suitable for large sizes, and it becomes manifest that the interior pole design possesses several advantages. And the drift of German practice is, apparently, towards this type. Led by Siemens and Halske, with their 300-kilowatt machine, we had interior pole dynamos by several exhibitors ranging down to sizes as small as 15 kilowatts. That there is any gain in employing inside poles for machines of the latter size is very doubtful, but for larger sizes it is different. In the first place, the commutator is done away with, the armature bars, separated by cardboard, themselves serving as segments. Next, the weight of iron in the field magnets is largely reduced by placing them inside instead of outside the armature, as the yoke ring in the former case has a diameter considerably smaller than that of the armature, while if outside, its diameter would be considerably larger.

The overhanging of the armature from the star wheel is not an attractive feature, and it has been suggested that, apart from the wearing of the bearings, it will be difficult to keep the ring central. But provided the insulation of the bolts stands—and to his question on the point the writer received favourable replies—there is no danger to be apprehended on this score. In fact, the objections to the inner pole machine seem to have been founded more on imagination than on reality, and may be taken as an illustration of the suspicion with which the Britisher is prone to look upon new departures. Nor will the Germans heed our criticisms much until we have something comparable with their machines to point to. In size they are far beyond us; our criticism provokes their smiles; our remarks they laughingly answer with the triumphant rejoinder: "Well, these are our machines, 600 kilowatts, at 100 revolutions: have you anything like them? When you can show us anything half as big in London, we will pay you a visit."

But, as previously stated, we have no figures of efficiency, and that is a great pity. The engines shown were generally of splendid workmanship and finish, and would probably be on a par as regards steam consumption with our engines of the same type. Only in one case was the consumption of steam per kilowatt hour stated, and then we are not very sure of the conditions. That the engines employed in central stations must, for economical reasons, work as fully loaded as possible is now generally recognised, the consumption of steam per unit being very much increased at light loads. The consumption of a steam dynamo may be expressed approximately in the form $q = a + b\,k$, where q is the quantity of water used per hour in lbs., k, the output in kilowatts, and a and b constants.* From this we learn that even when no electrical work is being done, there is consumed a certain quantity of water, a, in overcoming engine friction, supplying power to excite the dynamo, hysteresis, &c., while the amount consumed over and above this "idle water" is proportional to the electrical work being done. For example, a 200 kilowatt combination, consisting of a compound condensing engine, coupled direct to a good dynamo, might have for a a value of about 1,200, while b would be probably somewhere between 18 and 20. Taking the latter figure as expressing more nearly the results obtained in practice, the water consumption at full load would be $= 1{,}200 + 200 \times 20 = 5{,}200$ lbs. or 26 lbs. per kilowatt hour, while at half-load it would be $= 1{,}200 + 100 \times 20 = 3{,}200$ lbs., or 32 lbs. per kilowatt hour. These figures are given not as actual results but merely to show the effect of working at light loads, the water consumed per unit at half load being greater in this case by 25 per cent. than that consumed at full load. Designing the station plant so that the engines are fully loaded is of the greatest importance, and recollecting that one of the most striking features of the Frankfort Exhibition was the size of the dynamos, we realise that the stations which would justify from an economic point of view the use of such machines in this country, only as yet projected.

As regards the alternators, there was little that was striking, excepting the size. In the Siemens and Halske and Helios machines, not only was there iron in the armature, but this iron was disposed so that the magnetic flux was subject to continual change as the magnets approached and receded from the projecting coil cores. Though from an engineering point of view the iron core is a necessity, there is a strong feeling that its presence should not cause periodic fluctuation in the field, but at Frankfort this idea, like some others we have, was set at nought. For the Helios machine a high efficiency is claimed, but as regards Siemens and Halske's we regret being unable, in the absence of figures, to say whether the reaction between armature and field meant loss of power or not. It was just a little surprising, however, to see the modern practice of Germany exemplified in the case of Siemens and Halske by an alternator virtually similar in design to a machine made by M. Clerc seven years ago. Clerc's armature ring was formed of cotton-covered iron wire cut into pieces to make cores for the coils, the ends being turned inwards towards the magnets to form the projections. Siemens and Halske's armature ring is made of plates, but the difference, it will be noted, is, apart from size, one of detail only. With these observations the writer concludes his account of the Exhibition.

[ERRATUM.—Article VIII., page 653, third line from the top of right hand column, read 90° angular distance instead of "45° angular distance."]

AN ELECTRIC FIRE ENGINE.

SOME years ago Mr. J. C. Merryweather investigated the question as to whether electricity could be utilised economically for operating a fire engine. Although not quite satisfied that this could be profitably effected, he completed his plans. It was originally proposed to equip one of the leading cities with electrical fire apparatus, but it was found that the efficiency of electric as compared with steam fire engines was not assured, and at the same time it was uncertain whether the new engine would be easy to manage. The scheme was therefore abandoned, but since then Messrs. Merryweather and Sons have constructed an electric fire engine for the inspection of probable purchasers.

The electric fire engine is similar to the steam engines in use in the metropolis and various provincial towns. It is arranged on four wheels with fore carriage and capacious hose and implements and seats for firemen and driver. Instead, however, of the usual boiler, a Siemens motor is substituted for the operation of the pump. The engine is capable of pumping from 350 to 500 gallons per minute, and of throwing one jet to a height of 175 feet, two jets 145 feet, or three jets 100 feet. The pump is so constructed that it will draw its supply of water from tanks, streams, shallow wells, or direct from the street hydrants. The latter is regarded as a very important feature. The hose box contains from 1,000 to 1,200 feet of "double substance" canvas hose. As far as weight is concerned, that of the electric is rather more than that of the steam fire engine; but notwithstanding this, the former is easily drawn by a pair of horses proceeding at a gallop.

The current is derived through a manhole from an underground system, the connection between the motor and the latter being effected by means of a flexible piece of cable.

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* This fact, pointed out to me rather more than two years ago by Mr. Archibald Denny, of Dumbarton, has been abundantly confirmed by Mr. Willans in recent experiments. Mr. Denny arrived at the above result by testing Phœnix, and other dynamos coupled to compound engines, and the very apt term "idle water" is his.—W. B. E.

AN EXPOSÉ OF THE ELECTRIC GIRL.*

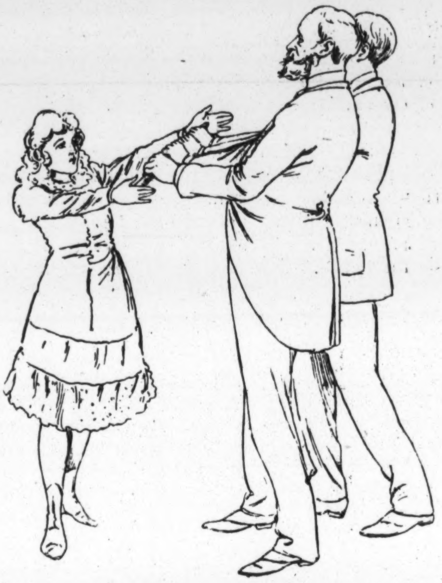
BY NELSON W. PERRY, E.M.

"ELECTRICITY is a mysterious agent, therefore everything that is mysterious is electrical." This is the logic of the masses, and we find it worked for all (and more than) it is worth in electric belts, hair brushes, tooth brushes, hurricanes, and electric or magnetic girls. "All cows have tails, but all animals that have tails are not cows" is the logic of the scientist. Now, the so-called electric girl performs some feats that are totally incomprehensible to the average spectator, and which seem at first to set at defiance some of the most familiar mechanical laws. She certainly astonishes, but she is not electrical. I propose in this article, after stating some of the things that she does, to show how she does them, and that the agencies employed are the very ones that her feats seem to defy.

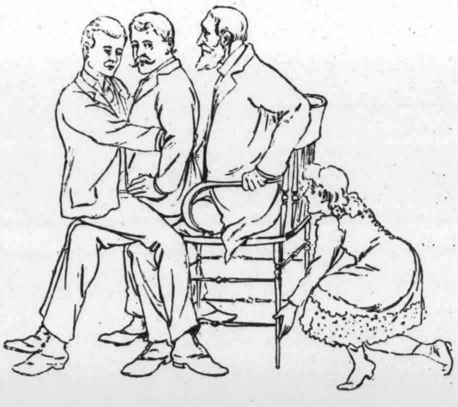
About the year 1883 vague rumours reached the North of the existence of a girl in Georgia possessed of extraordinary powers, supposed to be either magnetic or electrical, and a little later we heard of her appearing in public, and finally in dime museums, where her performances astounded all beholders. This girl's name was Lulu Hurst, and she is described by Prof. Simon Newcomb (*Science*, February 6th, 1885, pp. 106, 107, 108), who thought the case of sufficient importance to warrant investigation, as follows:—"Rosy country girl above medium height, but did not give the impression of muscular training; still, when she was introduced to those present (a committee of investigation of which Prof. Newcomb was one), the first thing which struck the writer was the weight of her arms. Shaking hands with her felt like moving the arm of a giant, and led to the impression that she had a much better muscular development than would have been supposed." Her success was so phenomenal that she soon had many imitators, and the dime museum manager who could not exhibit an electric girl once in a while was not up with the times. I have seen many of these imitators but not the genuine Lulu Hurst. I have had many conversations with people who have seen Miss Hurst, however, and I am led to believe that the imitators do the same things in the same way as she, and in some cases have improved upon her performances by greater expertness and by introducing new features.

The first performance I saw was in Cincinnati. Arriving at the museum a little early, I found a temporary platform or stage erected at one end of the hall. The supports for this platform were concealed by drapery. Not knowing the nature of the performance, it occurred to me to investigate what was beneath. Having satisfied myself that there was no trickery there, I awaited the performance. A little girl about 14 years of age, and slightly built, was introduced as the "electric girl," and a general invitation was extended for any strong man among the spectators to step up to the stage. It so happened that a gentleman with whom I was acquainted responded. He was fully 6 feet high, broad shouldered, and had considerable local reputation as an athlete, and he could not have weighed less than 200 lbs. A stout stick about 3 feet long, and as thick as a broom handle, was handed to him, and he was told to grasp it in the middle with both hands, and, with arms extended, to hold it as rigid as possible. The little girl then placed the *palms* of her *open hands* on either end of the stick, as shown in fig. 1, and after a few preliminary movements, soon had this strong man staggering about the stage apparently completely at her mercy, and at one instant a timely cessation of her endeavours only prevented him from being hurled ignominiously off the stage to the floor 3 or 4 feet below. It was a sight not soon to be forgotten—the utter helplessness of this giant in the hands of such a child. When he came down from the platform, I asked: "Well, how was it?" He replied, "I really do not know. She possesses a power against which I was helpless. I'd hate awfully to have her for a wife, but I'd give a good deal to know what's under that platform."

Three men then took hold of the stick, but she handled them as easily as she had my friend. Next an ordinary straight backed wooden chair was brought out, and on the request that a heavy man should come up, it was occupied by a man who satisfied the requirements. He gave his weight as 240 lbs., and looked it. He was instructed to hold the chair down at all hazards. The girl, approaching from behind, placed the palms of her *open hands* upon the two hind legs of the chair, and beginning with slight movements, she soon had the chair moving so rapidly around the platform, that the man who was sitting in it could scarcely keep his seat. Then, to exhibit her powers more fully, three men were invited to hold the chair down. They arranged themselves as shown in fig. 2, but the result was the same as when the chair was occupied by but a single individual. My position was such that I could watch the movements of the girl very closely, and while evidences of muscular exertion were not wanting they were by no means commensurate with what seemed necessary to produce the results obtained. In fact the evidence of one's senses was that had she ten times the strength she really possessed and had she exerted it all to the utmost, she must have failed.



THE ELECTRIC GIRL—FIG. 1.



THE ELECTRIC GIRL—FIG. 2.

One constituted as I am, cannot see such things without desiring a solution of the mystery, and I set about trying experiments. I soon found a solution, and with a little practice never failed to repeat what I had seen in a satisfactory manner, *provided all the conditions were right*. These conditions are that the subjects shall be strong and strive to do their utmost to oppose my efforts. If either of these requisites be wanting the experiment must be a failure.

In another city, where I happened to be recently, a magnetic girl was advertised, and as one of her performances was new to me, I went to see her, and accepted an invitation to a chair on the stage. Three other gentlemen also came up. While the lecturer was enlarging upon the girl's wonderful powers I had ample time to converse with my companions. I instructed them just how to hold themselves in each of the experiments, and promised that if they carried out my directions the girl could do nothing with them, and the *séance* would be a failure. The tricks already described were performed, and in each of them one or more of my companions were called upon to assist. I did not take part in these. In each of the performances they at first carried out to the letter my instructions, and the girl failed; but she complained so loudly that they would not do as she told them, and was so ably seconded in these complaints by her infuriated manager, that they were finally constrained to obey, and the performance proceeded successfully. The new (to me) trick was reserved to the last, and I was invited to take part. This is represented in fig. 3. Another gentleman and myself were handed a strong stick, about 4 feet long, which we were told to grasp with both hands and hold in a vertical position. The girl placed her *open* hand against the side of the lower end, as shown, and we were told to press down as hard as we could. I know I used my utmost strength, and, presumably, my companion did also, but in spite of all our efforts we could not cause the stick to slide past her open hand. Had she grasped the stick in both hands with a firm hold she could not have held it against the efforts of either of us alone. I was not long in experimenting on this, and in learning how it was done. It is one of the most effective tricks in the *repertoire* of the electric girl, and at the same time can be very easily acquired. As it throws so much light on the other tricks, I will explain it first.

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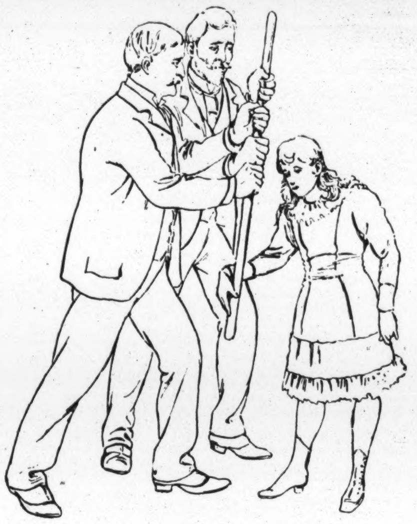
* American *Electricity*.



THE ELECTRIC GIRL—FIG. 3.

The two men are required to stand side by side, and the girl, facing them, places the palm of her hand on the side of the stick away from her, or on that side towards which the men are facing. She is also careful to place her hand as far from theirs as possible, thus gaining considerable leverage. She begins by moving her hand up and down on the stick, first very slight, but with gradually increasing pressure, as if to make better contact. This diverts the stick from the perpendicular, and she tells them to hold it straight. As they endeavour to do this they are working to a very great disadvantage, having little or no leverage, whereas she has a foot or two. The strain on her is very slight, first, because of the leverage in her favour, and, second, because it is merely tensional in the direction of her arm. When she thinks she has sufficient pressure on her hand the order is given to the men to press down as hard as they can. They think they are exerting a tremendous vertical pressure, but the fact is their efforts are almost entirely consumed in keeping the stick vertical against her pull at the lower end. They know they are expending some energy in this way, but are confident that most of it is expended in vertical thrust. There is, of course, some of this, but their efforts to counteract her pull cause sufficient friction between her hand and the stick to support that thrust or its equivalent weight. To determine just what this weight was, I called in the assistance of two powerful men. We all weighed ourselves on a spring balance. One weighed 167 lbs., the other $161\frac{1}{2}$ lbs., and I weighed 166 lbs. Now, if I remained on the scales while the other two were pressing down on the stick, the excess over 166 lbs. indicated by the spring balance would be the measure of the vertical effort exerted by them. The result was astonishing. With these two men exerting every muscle to force the stick to slide past my open hand they failed, and the balance indicated in one instance but 191 lbs., and in another 190, thus making their united efforts in a vertical direction 25 and 24 lbs. respectively. Most of their effort was, unknown to them, in a horizontal direction. If my arm took the direction of the resultant of these two forces, which it most naturally would, the strain on me would be merely tensional in the direction of the length of my arm.

In the experiment illustrated in fig. 1 the subject is enjoined to hold the stick perfectly rigid. The girl, on account of the immense leverage she has, with but very slight pressure on the ends of the stick can move not only the stick, but the arms and body of the subject. This she does slightly at first, increasing her efforts gradually. These are opposed with increasing force until she thinks he is exerting himself sufficiently, when she suddenly either relaxes her efforts entirely or exerts them in another direction. Totally unprepared for this change of base the victim is thrown off his balance and is then at her mercy. The stronger the man and the more he opposes her the better. It is still easier to do this with two or three men than with one, for there is no concert of action between them, and after they are once off their balance the girl's efforts need scarcely be more than directive. If this be done with some skill the men will throw themselves, and little is left for the girl to do but to follow them up.

In the chair trick, ninety-nine men out of a hundred when told to hold the chair down will place their hands on the seat or arms of the chair, and throw their weight almost entirely on their feet. If they do not do this at first they will the moment they are conscious of the girl's effort to raise the chair, thus unconsciously assisting her. To raise the chair the operator merely pushes against the back of the seat; she does not lift. She is assisted in doing this by her knees, which she brings to bear against her elbows or forearms, and also by the leverage she has between the man's feet and her hands. Once the chair is raised ever so little, the hardest part is accomplished. She at once relaxes her efforts and he falls back, or by a sideways movement she shoves the chair to one or the other side. In either case he is off his balance, and skilful manipulation on her part before this balance is regained causes him to throw himself in almost any direction she desires with little expenditure of energy on her part.

The difficulty is not increased when another man sits in the first one's lap, and when there are three, arranged as in fig. 2, the task is much simplified. It is evident that the third man acts as a counterpoise to the one in the chair, and the whole system resembles a balanced beam with centre of gravity high, and, therefore, in a state of equilibrium approaching instability.

To perform these tricks successfully requires some expertness, but this may be acquired by a little practice. The most effective and yet the simplest of them all is that represented in fig. 3. On the second or third attempt a friend of mine performed it as successfully as the girl from whom I learned it.

The above article was prompted by the following clipping from the editorial columns of the London ELECTRICAL REVIEW of November 13th:—

> The *Daily News* last week gave a very thrilling and exciting account of the remarkable feats performed by an American lady in the presence of a number of doctors and well-known scientists, including Profs. Crookes, Perry and Dr. Lodge. Our contemporary credits Mrs. Abbott with bringing from the United States the latest puzzle in electrical phenomena, for she modestly ascribes the seemingly incredible feats which she accomplishes to electricity or to animal magnetism, Her peculiarity lies in her marvellous strength, although there was no unusual muscular development in her arms or shoulders, neither was any strenuous exertion displayed by her. Mrs. Abbott lifted four gentlemen, packed somehow on a wooden chair, without any apparent undue exertion. Regarding these mysterious actions Dr. Lodge wrote to the *Daily News* on the 8th inst., in which letter he states that it was half suggested in their description that

> the surprising feats were supposed by those present to be attributable in some occult way to electricity or magnetism, and as he was present at the time, he thought it incumbent on him to state that, whereas the feats themselves were, on the whole, very fairly described in the *Daily News* article, there was, in his opinion, not sufficient ground for believing them to be accomplished by anything more abnormal than the extraordinary muscular power and skill of a small woman in good training. Profs. Crookes and Perry also disclaim that the feats witnessed were in any way attributable to animal electricity or magnetism which the lady may have possessed in a special degree, but we can well understand how it might be possible to bring electromagnetism to the assistance of the performer in the lifting and non-lifting experiments.—*Electrical Review*, London.

When men of such world-wide reputations as those enjoyed by our own Simon Newcomb, and Profs. Crookes and Perry and Dr. Oliver Lodge, of England, deem these displays worthy of investigation, and when the editor of one of the leading electrical journals of Great Britain sees fit to suggest the agency of electro-magnetism as a solution of the problem, it seemed to me it would not be uninteresting to readers of *Electricity* to hear the true explanation of these seeming marvels from one who has many times performed them all for the edification of his friends.

STATIC ELECTRICAL MOTORS.*

In our issue of August 1st of this year we published a brief account of a static electromotor devised by Mr. James Wimshurst, of England. Mr. Wimshurst is the author of the static or influence machine which bears his name, and his motor is but a modification of the machine. To quote from the account to which we refer :—" It consists of a glass disc, mounted on a vertical spindle, and carrying on one face a number of tinfoil sectors. The upper face of the disc is touched at two places by brushes connected by wires to the poles of the influence machine, while at right angles to the diameter joining these brushes there are two other brushes connected by an equalising rod. Below the rotating disc is a stationary one, having upon it two sectors of tinfoil extending about 90°. These sectors are also in communication with the poles of the influence machine. As soon as the latter is put in motion the glass disc begins to rotate, and rapidly attains a very considerable speed, turning with an amount of force which is quite remarkable." Those of our readers who are familiar with the well-known pith ball experiments, and who also have a knowledge of the construction of the Wimshurst machine, will have no difficulty in forming a mental picture of the motor in operation.

Taking the above somewhat meagre description of Mr. Wimshurst's production, Mr. William McVay, of 19, East Sixteenth Street, New York, has constructed a motor which is very gratifying and instructive in its operation. We illustrate it in fig. 1. Mr. McVay employs two glass discs, each 12 inches in diameter. The upper one, which rotates, bears upon its upper surface 16 tinfoil sectors, 3 inches in length, and in width from a quarter of an inch at the *inner* ends to five-eighths of an inch at the *outer* ends. The lower disc, which is stationary, carrying the 90° sectors, is supported four inches above the base by a piece of hard rubber tubing. The spindle to which the upper disc is attached is also of hard rubber. The metallic conductors, supported at either side of the discs by the standard of the frame, have each two arms, bearing at their extremities small brushes made of tinsel. One arm of each conductor passes under the lower disc, and presses its brush against one of the 90° sectors of the stationary lower disc, and the other arm is extended over the upper disc, and presses its brush lightly against the sectors of the rotating disc as they pass. When the sectors of the rotating disc are brought into contact with a brush carrying a charge of electricity of one sign, they become similarly charged, and are, consequently, attracted by the sector on the lower disc, which is constantly charged with electricity of opposite sign. The equalising rod, the position of which may be seen in the illustration, serves to discharge the sectors and put them in a neutral condition preparatory to their being recharged.

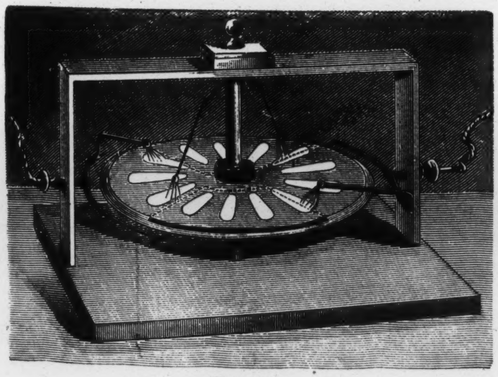


Fig. 1.

The motor may be made to turn with equal velocity in an opposite direction by connecting both sets of charging brushes with one pole of the machine and attaching the conductor from the opposite pole to the equalising rod, or by " grounding " the rod. In fact, it is a very accommodating motor, willing to do anything within its power to oblige. It occurred to Mr. McVay that there was no good reason for an adherence to the form of motor adopted by Mr. Wimshurst, and as a result he has produced four motors of his own design, all of which we illustrate. They furnish an excellent example of the evolution of an idea. In fig. 2, Mr. McVay employs two glass shades as substitutes for the glass discs. The smaller shade is supported by a glass tube and is stationary, while the larger one is placed over it and turns on a point fixed to the top of the inner shade. Our artist has done his work so well that further explanation of the construction is not deemed necessary. A more elegant design is shown in fig. 3. This motor

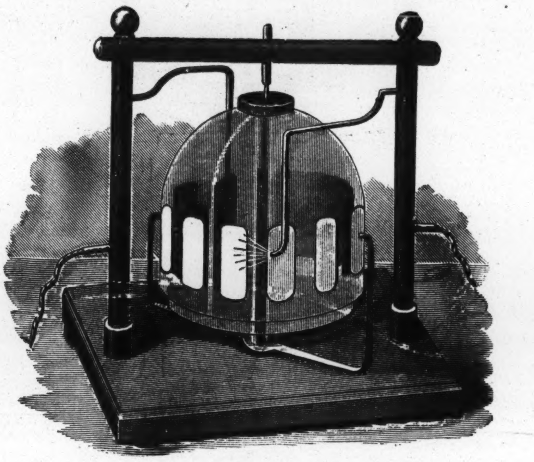


Fig. 2.

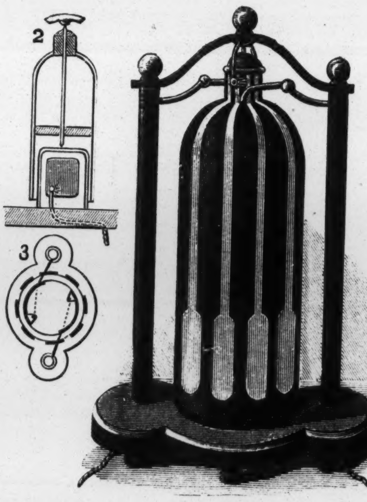


Fig. 3.

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* *Scientific American.*

stands about 19 inches in height, and has the appearance of being constructed entirely of hard rubber and brass. A glass shade is also used in this case, but instead of utilising another shade as a carrier of the 90° sectors, as in fig. 2, an inverted battery jar serves the purpose, and at the same time furnishes a support for a glass spindle upon which the cylinder turns; thin brass brushes are substituted for the tinsel used in making contacts in the previous motors. When one sees this motor in operation, running as it does at a high rate of speed, it seems incredible that the motive power is static electricity.

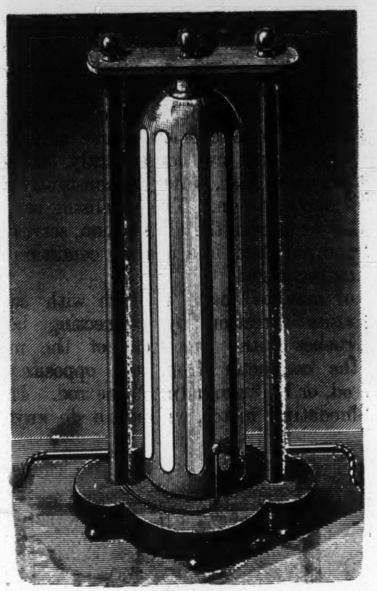

FIG. 4.

Fig. 4 is so simple in its construction that the principle upon which it works can be understood at a glance. In the construction of this device a glass shade is also employed. It carries upon its surface eleven strips of thin sheet brass about 6 inches in length and half an inch in width.

In this case the pillars at either side serve the same purpose as the 90° sectors in figs. 1 to 3, as they are constantly charged with electricity of opposite sign, and consequently there is a strong attraction between them and the sectors carried by the cylinder when they become charged in turn by coming in contact with the brushes, which are so situated that they come in contact with the sectors when the latter are about an inch away from the pillars, which, by the way, are also of brass. The speed attained by fig. 4 is remarkable, and when it becomes thoroughly charged it shows such a decided inclination to leave its base that it has to be held down. In fig. 5 we have the static electromotor in its most efficient form. It does actual work, and is here shown rotating a Geissler tube, which is lighted by the same machine that furnished the power for the motor. The optical effect of the rotation of the tube is shown in fig. 6. This motor is constructed entirely of brass, rubber, and wood, and consequently is less fragile in appearance, and is suggestive of real power.

The cylinder of this motor is of hard rubber, and is 6 inches in length and about 4½ inches in diameter, with brass sectors ¾ of an inch in width running along the full length of the cylinder. The cylinder has a $\frac{3}{16}$ths inch iron rod passing through it. The rod has steel ends where it comes

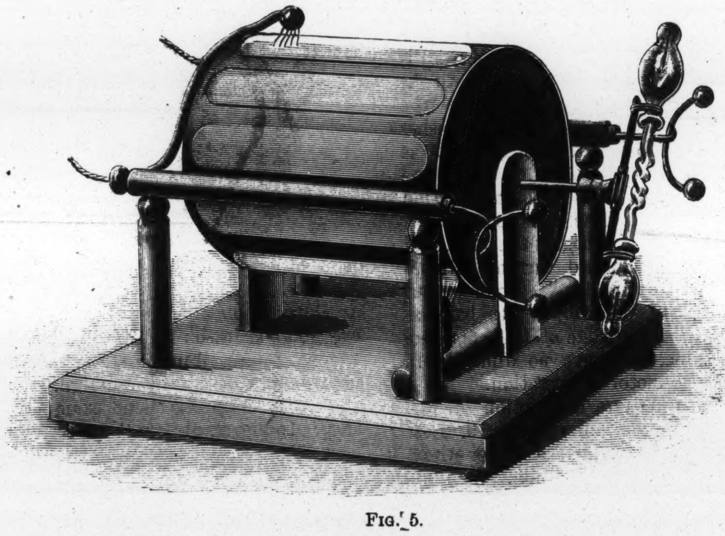

FIG. 5.

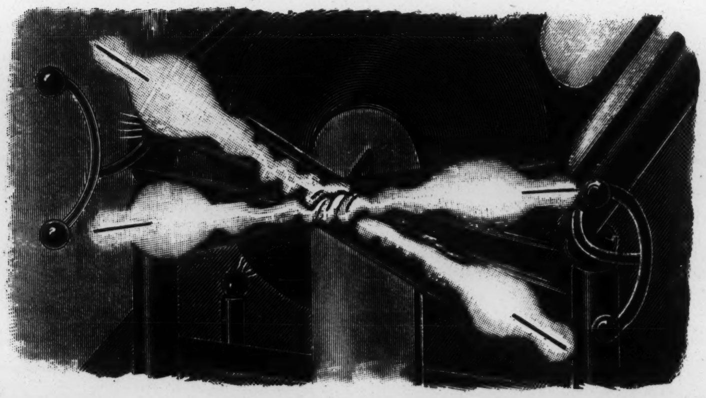

FIG. 6.

in contact with the brass bearings. The supports for the cylinder are of hard rubber, as are also the supports for the pole pieces, which will be seen at either side of the cylinder. The dielectric used as a covering for the pole pieces is sheet rubber. The points at which the sectors receive their charges may be seen at the right-hand side of the cylinder, at the rear, and at the left-hand side of the front end. The position of the Geissler tube is well shown in the accompanying illustration. The projections from the ends of the pole pieces are for the purpose of lighting the tube, which presents a very weird appearance in a darkened room. The subject of the motive power of static electricity is one filled with interest for the student and well worthy of attention.

Mr. McVay has in mind a modified form of fig. 5, from which he hopes to obtain greater efficiency and a decided improvement in appearance.

REVIEWS.

*L'Electricité dans la Nature.** By Georges Dary. Paris: Georges Carré.

We have had latterly an ample supply of manuals treating of electricity as artificially generated and collected and employed, for good or for evil, in the service of man. The present volume, which is one of a series, entitled, "*Bibliothèque Internationale de l'Electricité et de ses Applications*," deals with electricity as it is met with in Nature—*mild* electricity, as we may venture to call it—and as it acts often very energetically in man's dis-service.

M. Dary has done full justice to his important subject. We had almost said that every manifestation of electric energy, every natural phenomenon in which electricity plays a leading part, is here fully discussed. There are only two exceptions. We find no allusion to the electric currents undeniably evolved in plants and animals, or, again, to electric action in the formation and deposition of metallic ores in the various strata of the earth. But into electro-meteorology M. Dary enters fully and judiciously. After proving the occurrence of electricity in the atmosphere, he describes its distribution, its daily and annual variations, its geographical distribution, and its fluctuations according to altitude. He then launches out into the realms of space, and speaks of comets, nebulæ, and the solar spots. Here, of course, we find ourselves on controversial grounds. Whilst some authorities consider that the cyclical recurrence of the sun spots occasion, by electric mediation, a periodicity in the weather upon our earth, in seasons of plenty or of dearth, in the inroads of locusts, in pestilence, commercial crises, and even in political agitations, others speak of "sun-spottery" with derision. Luvini, as here quoted, considers sun and earth as two vast electro-magnets reacting upon each other. Every change of intensity must occasion perturbations certain to be felt more or less distinctly in every department of nature. The great objection to this view is that the weather—and consequently the crops—has been not many seasons ago known to be wretched in western Europe, whilst Hungary, Turkey, and Russia rejoiced in sunshine and in a plentiful harvest.

Thunderstorms, the most commonly recognised electric phenomenon, are, of course, discussed at length. The author mentions, doubtfully, the rare case of lightning ascending from the earth. Many cases of globe-lightning are given, apparently on good authority. M. Mascart, indeed, questions the objective reality of these appearances. He suggests that the spectators have been dazzled by lightning and fancy in consequence that they see round spots or balls of light. This explanation, we submit, is quite inadmissible. If we have been dazzled, whether by the sun, by lightning, or by an arc light, we certainly see round luminous spots. But these spots appear instantly wherever we cast our eyes, whilst the the globe-lightnings move steadily on in some given direction at a moderate speed. They are often described as often breaking up into fragments, sometimes with a loud report. Hence we cannot refer them to the dazzled sight of the observers.

The occurrence of violent thunderstorms not attended by rain is described as occasionally met with. In Queensland, during a long drought, such storms were of frequent occurrence. It was suggested that owing to the intense dryness of the atmosphere the rain-drops were evaporated before reaching the ground.

A theory is mentioned to the effect that storms are most rare in metalliferous regions; but observations made at the iron mines of Grandone, near Genoa, would lead to the very opposite inference.

The important question is raised whether thunderstorms are becoming more or less frequent? In Belgium, according to M. Lancaster, the annual average in the period between 1833 and 1877 has risen from 13·1 to 19·3.

Volcanic thunderstorms are next considered. It is evident that lightnings are generally seen playing in the columns of clouds ascending from the crater of Vesuvius. Palmieri, who occupies the observatory placed near the summit of the mountain, reports that the smoke is constantly charged with positive electricity whilst the falling ashes have always a negative charge.

Planté, who considers the earth as electrised in its entire mass, maintains that this electricity escapes during eruptions. Others, it must be remembered, view volcanic lightnings as a mere secondary phenomenon traceable to the formation of steam clouds.

It appears that in many rural districts in France there still prevails the deplorable superstition that thunderstorms may be dispersed by ringing the church bells. The error of this belief is proved by the fact that during 33 years, in France, the lightning has struck 386 bell-towers, and killed 103 ringers in the act!

M. Dary mentions the strange opposition which the use of lightning-conductors encountered in France. M. de Boisvallée, a nobleman residing near St. Omer, had erected a lightning-rod on his château. The Municipal Court of St. Omer ordered its removal. De Boisvallée appealed to a higher court and judgment was given in his favour. His counsel at the trial was no one less than Maxim-Robèspierre, afterwards so notorious.

Space does not allow us to follow the author in his account of hailstorms, waterspouts, tornadoes, cyclones, and earthquakes, all of course, considered from an electrical point of view.

We cannot help sympathising with him in his regret that so many points in our knowledge of electricity are still left doubtful. He complains that in our days aeronauts instead of studying the physical, and especially the electrical conditions of the atmosphere, are engaged in devising "aërostats" for the encouragement of aggressive warfare and piracy.

We consider M. Dary's work as most valuable, and we must strongly recommend it, not merely to the philosophical electrician, but to all physicists and meteorologists.

Electricity Treated Experimentally. By Linnæus Cumming, M.A. Third Edition. London: Longmans, Green & Co.

The chief additions to this small treatise relate to dynamos, but other small alterations have been made in various chapters, thus bringing the work as far as possible up to date.

The Chronograph. By Capt. H. C. L. Holden, R.A. London: Biggs & Co., 139, Salisbury Court, Fleet Street.

This pamphlet is a manual descriptive of the Boulengé type of chronograph, as modified and improved by the author. Except to those interested in matters dealing with the measurement of shot velocity, the description is of but little interest. The price charged (5s.) is decidedly high.

Electricity up to Date, for Light, Power, and Traction. By J. B. Verity. London: Frederick Warne & Co.

This book professes to instruct the public, who are said to have practically no other work of the kind available; this can hardly be admitted. It is all right as far as it goes; the important question of cost, however, in which the public are greatly interested, is not referred to at all.

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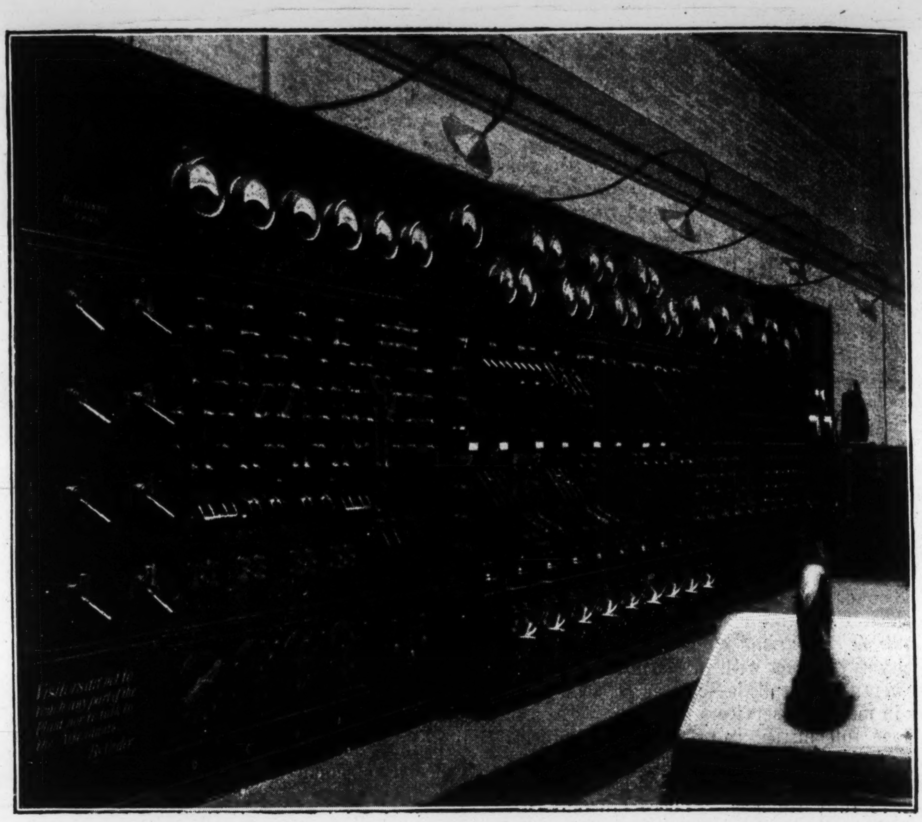
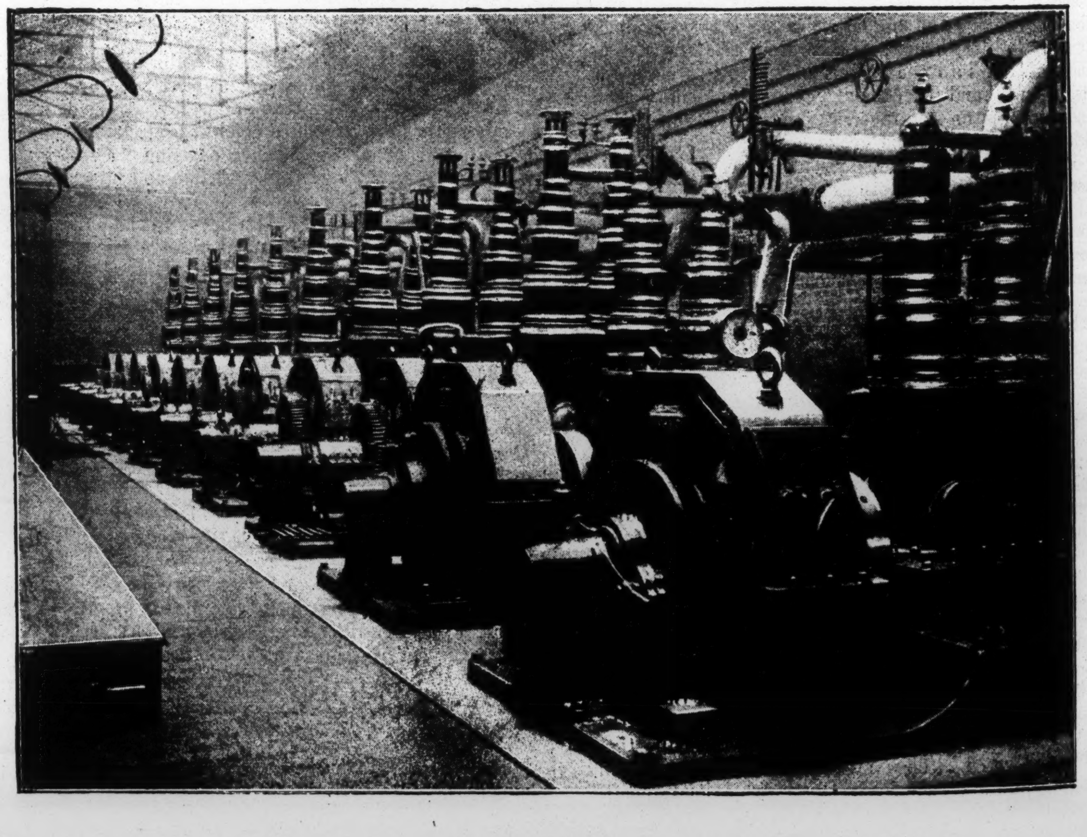
* Electricity in Nature.



View of Switchboard.



Interior of the Regent's Park Station.

ELECTRIC LIGHT IN ST. PANCRAS.

No small honour attaches to the Metropolitan Local authority which is first possessed of the courage to undertake the supply of electricity to the community over which it exercises control. The difficulties and prejudices which a Vestry has to meet, when carrying out a great scheme, are such as are not encountered by public or private companies. Keen and sometimes unjustifiable criticism, the promptings of diverse motives, invariably assail the measures of local authorities, and we fear that unfair methods are often adopted to hinder the progress of work. In overcoming the opposition in the Vestry and bringing the electric light scheme into the present satisfactory state, the Electricity Committee of the St. Pancras Vestry are deserving of praise.

The provisional order or license was granted to the Vestry as far back as 1883, but it was not until the latter part of last year that a definite proposal was made for lighting the district. We believe we are right in assuming that the order was obtained in 1883, not so much with the object of commencing work as to keep electric light companies out of the district. This end attained, the matter was allowed to rest, but the following seven or eight years, were utilised by Mr. Gibb, and the Electricity Committee in watching the progress in the electrical world; in obtaining a thorough knowledge of the systems which were from time to time adopted in London, and in noting improvements which were likely to be of ultimate service. Thus possessed of authentic information, it was with confidence that the Electric Light Committee recommended a scheme to the Vestry at the beginning of 1890. Opposition to the Vestry carrying out the scheme sprang up, but the arguments of the committee were not to be gainsaid, and a majority of the Vestry sanctioned the project. Suitable ground was found off the Euston Road, and on November 5th, 1890, the foundation stone of the first electric light station was laid. Twelve months within a few days elapsed, and on the 9th of last month the vestry turned on the current for the first time. So rapidly has the demand for the light increased that at the present moment 5,000 16-C.P. lamps are supplied—no mean progress when we consider that the whole output of the station is but 10,000 lamps.

Our illustrations give a clear view of the interior of the Regent's Park Station.

There can be but one opinion as to the arrangement of the generating plant. We can safely say that the station as a model occupies a high position. A system of three-wire low tension has been adopted, the current being distributed by means of feeders. There are fixed in the station nine low-tension Kapp multipolar dynamos of 680 ampères each, working from 130 down to 100 volts. In addition are two high-tension dynamos (coupled), intended to be used for street lighting. Four secondary batteries of 60 cells, by the Electric Construction Company, are used during the hours of minimum supply. They are conveniently arranged in two sub-stations, one attached to the central building, the other being situate some distance away. These four sets of batteries may be charged up simultaneously by the high-tension dynamos. Willans triple expansion engines are used at a steam pressure of 175 pounds.

The switchboard which we illustrate has been made by the Electric Construction Company.

Although street lighting has not yet commenced, mains have been laid down five miles of streets; arc light standards have been fixed in some of the principal streets, and it is thought that in a few days the street lamps will be lighted. The mains are copper strips, measuring 1½ inches by ⅛-inch, laid on porcelain insulators. The meters generally used are of the Aron and Ferranti types.

The whole of the work has been done under contracts; a loan being raised by the vestry on the security of the rates.

The inhabitants of the district were not slow to see the advantages accruing to the use of the electric light, and before a single lamp was lighted contracts had been sealed for 6,000 lights. The remaining 4,000 lamps will be speedily taken up, and the necessity of a new station, or a further extension of the present one, will be soon apparent.

The price charged for the current is 6d. per Board of Trade unit, and if there is a profit of more than 7 per cent. the consumers will reap the advantage.

We have given briefly the chief points which occurred to us on a visit to the station, and we have been assisted in giving this information through the kindness of Mr. Gibb, the vestry clerk, and the manager of the station, Mr. Baron.

It is reasonable to expect that the work of the St. Pancras Vestry is attracting the attention of local boards, and no doubt the successful operation of the station will have a good effect in assisting local bodies to arrive at some determination concerning the introduction of the electric light. But it must be borne in mind that the good results obtained in St. Pancras are due in a great measure to the skilful handling of the question by Mr. Gibb and the Electricity Committee, and this skill has only been obtained by a long and careful study of the subject of electric lighting generally.

PROCEEDINGS OF SOCIETIES.

The Institution of Electrical Engineers.

ON THE SPECIFICATION OF INSULATED CONDUCTORS FOR ELECTRIC LIGHTING AND OTHER PURPOSES.* By W. H. PREECE, F.R.S.

(*Concluded from page* 376.)

CLASSIFICATION.

THE classification of insulated conductors is most varied and perplexing as regards the dielectric. The most systematic method is that of Siemens as regards the conductor. The pattern number gives the length in yards, which has a resistance of one-tenth of an ohm; divided by 4, it gives its carrying capacity in ampères; divided by 5, it gives its weight in lbs. per mile; divided by 6, it give its sectional area in mm.^{2}; divided by 4,000, it gives its sectional area in square inches. Nothing can be more charming. But when we come to insulation, we have types G, H, J, P, Q, R, L, M, N, LL, MM, NN, LLL, MMM, and NNN—all differing in the number and thickness of layers of pure rubber, of vulcanised rubber, of "special prepared material," in taping, braiding, preserving with compound, lead, tarred jute yarn, and iron sheathing, and also in insulation resistance per statute mile in megohms at 60°.

N, NN, and NNN are intended for 250, 2,500 and 5,000 volts respectively, and they vary in price in the ratio 64, 79, 93.

We are, however, told that they are tested in water *when not intended for dry places*, and Messrs. Siemens show that the insulation resistance diminishes as the size of the conductor increases.

For instance, type R: "Insulated with one layer of pure and two of vulcanised rubber, taped [braided, and drawn through preservative compound]. Tested under water, insulation resistance from 2,000 to 700 megohms per statute mile at 60° F., according to size of wire." The words in brackets form the sole difference between types J and R!

The Silvertown Company work up by areas of conductor, advancing by twentieths of a square inch, between $\frac{1}{10}$th square inch and 1 square inch. The insulator is composed of pure rubber—their best vulcanised India-rubber. They used to endeavour to maintain a constant ratio of diameters of conductor and dielectric, but the insulation resistance now varies with size. The wires are all rigidly tested under water, and give over 2,500 megohms per mile.

But the classification into letters is as perplexing as with nearly all the other makers, except, perhaps, the Fowler-Waring Company, who have only one dielectric and one form of protection, viz., lead covering.

The Standard Underground Cable Company, of U.S.A., who use Waring's compound, specify the thickness of insulation in mils. Their smallest is 31 mils., 9 mils. less than the proposed minimum. Their thickest is 188 mils., or 7·5 mm., which is good enough for 7,000 volts.

This classification into types is a manufacturer's question. We cannot interfere with it, but we do earnestly hope that they will study the convenience of the user by reducing their types to the lowest possible number, but, above all, by removing from their lists the cheap and nasty.

The evil of this loose system was strikingly exemplified in a case which recently came before the law courts, when some of the ablest counsel were busily employed for several hours in endeavouring to explain what was meant by "C" quality wire, with but little result, none of the expert witnesses present being able to throw any light on the subject.

I am much indebted to different firms for the information which they have cheerfully given me to enable me to determine the specific insulation of the different materials they use; and as this information may be very useful, I tabulate it, and submit it herewith.

This table must not be taken as a competitive examination of the relative merits of the different goods. I have taken them just as they came and I have not indicated the classification, simply because I did not know it.

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* Paper read December 10th.

SPECIFIC INSULATION (σ) OF ELECTRIC LIGHT CABLES MANUFACTURED BY VARIOUS FIRMS.

Manufacturer.	Conductor.			Dielectric.				Insulation per mile at 60° F.: megohms.	Specific insulation (σ).	Remarks.
	No. of wires and approximate gauge.	Diameter. (d).		Thickness (t).		Diameter (D).				
		inch.	mm.	inch.	mm.	inch	mm.			
Siemens Bros. ...	7/22	·084	2·14	·076	1·93	·236	5·99	16,180	15·84	Insulated with "Siemens's special" high insulating India-rubber.
” ...	”	”	”	·078	1·98	·240	6·10	18,270	17·60	
” ...	19/15½	·340	8·64	·080	2·03	·501	12·72	1,022	2·67	Ordinary pure and vulcanised rubber.
” ...	61/15½	·612	15·54	·168	4·27	·949	24·10	824	1·90	
” ...	51/12	·850	21·59	·190	4·82	1·230	31·24	4,082	11·17	Lead-cased; insulated with specially high insulating fibrous material. (Bradford Corporation mains.)
” ...	37/13	·651	16·53	·096	2·44	·844	21·43	2,567	10·00	
” ...	19/14	·410	10·41	·079	2·01	·568	14·42	3,794	11·77	
” ...	7/13	·286	7·26	·079	”	·444	11·28	6,389	14·69	
” ...	60/6½	1·656	42·06	·113	2·87	1·882	47·80	624	4·93	Lead-cased; insulated with impregnated fibrous material. (St. James's and Pall Mall Company's mains.)
” ...	”	”	”	”	”	”	”	830	6·56	
” ...	60/10	1·170	29·72	·114	2·89	1·398	35·51	851	4·83	
” ...	”	”	”	”	”	”	”	1,014	5·76	
Silvertown... ...	19/15	·360	9·14	·144	3·66	·648	16·46	6,768	11·64	Special pure India-rubber, then vulcanised India-rubber.
”	”	”	”	”	”	”	”	6,664	11·46	
”	”	”	”	”	”	”	”	6,549	11·26	
Callender	7/16	·192	4·88	·154	3·91	·500	12·70	380	·40	Vulcanised bitumen.
”	19/18	·240	6·10	·155	3·94	·550	13·97	400	·49	
Glover	19/13	·460	11·68	·115	2·92	·690	17·52	600	1·50	Ordinary pure and vulcanised rubber. In use at the G.P.O. (specified 300 megohms per mile).
”	”	”	”	”	”	”	”	515	1·28	
”	”	”	”	”	”	”	”	560	1·40	
”	7/16	·192	4·88	·055	1·40	·302	7·67	855	1·91	
”	”	”	”	”	”	”	”	813	1·81	
”	”	”	”	”	”	”	”	833	1·86	
Fowler-Waring ...	1/18	·048	1·22	·036	·91	·120	3·05	6,522	7·20	Waring compound.
” ...	1/16	·064	1·62	·043	1·09	·150	3·81	6,619	7·85	
” ...	7/16	·192	4·88	·078	2·03	·352	8·94	4,835	8·07	
” ...	19/18	·240	6·10	”	”	·400	10·16	3,280	6·48	
” ...	19/16	·320	8·13	·095	2·41	·510	12·95	3,312	7·18	
” ...	19/15	·360	9·14	·100	2·54	·500	14·22	3,145	7·19	
Henley	1/10	·128	3·25	·046	1·17	·220	5·59	564	1·05	Ordinary pure and compound India-rubber.
”	7/16	·192	4·88	·054	1·37	·300	7·62	406	0·92	
”	19/18	·240	6·09	·060	1·52	·360	9·14	329	0·82	
”	1/14	·080	2·03	·040	1·02	·160	4·06	4,440	6·48	Ozokerited India-rubber.
”	3/20	·078	1·98	·039	·99	·157	3·99	5,240	7·57	
”	7/15	·216	5·49	·057	1·45	·330	8·38	2,210	5·27	
”	19/14	·400	10·16	·080	2·03	·560	14·22	2,000	6·01	
”	61/15	·648	16·46	·111	2·82	·870	22·09	2,200	7·55	
”	61/12	·936	23·77	·217	5·51	1·370	34·79	7,146	19·98	Special cable—Class AA.

SPECIFICATION.

The consulting engineer can afford to smile at classification, for he can draw up his own specifications; but it is extremely difficult even to do this without a reference to some well-known maker's class.

No wire should ever be used which cannot be subjected to a test under water. Insulated wire is supplied which is specified *to be used in dry places only.* But as this stuff is cheap, inspection is ignored, and dry places are not always dry; its general use follows; dampness and leakage result, electrolysis sets in, and the conductor is eaten away, if it is not charred, or even set on fire.

It is impossible to speak too strongly on the terrible abuse of ordinary precautions which is encouraged by the manufacture of these cheap cables. It destroys confidence, introduces danger, and discourages the industry.

A very curious practice has recently developed itself among our wiring contractors. They have asked manufacturers to reduce the over-all diameter of their insulated conductors, in order to enable them to utilise the grooved boarding which they happen to have in stock. In other words, the interests of the users of the electric light are to be sacrificed to the interests of the wood-carvers!

I do not believe in danger to person in high-pressure systems when proper material is used. They are so safeguarded, that any contact between primary and secondary—practically the only source of danger—leads at once to safety. I fear more danger of fire in both systems, and this more in low pressure systems than in high pressure ones, for they are not so safeguarded, and are more open to abuse. In fact, the numerous accidents that have occurred from imperfect work on low pressure systems has already attracted serious attention to its dangers.

I prefer, then, to specify that—

1. The copper must be pure, and such that at a density of 8·9, its specific resistance is 1,616; that is, it must comply with Matthiessen's standard of pure hard drawn copper.
2. If it is to be covered with any vulcanised material, it must be *tinned.*
3. No single size smaller than No. 19 (·04 inch or 1 millimetre wire) is to be used.
4. No single wire greater than No. 16 is to be used.
5. All larger sizes are therefore to be stranded.
6. The weight of copper used is to be such that the loss of volts between the distributing switch and the furthest lamp, when full load is on, shall not exceed 1 per cent. Hence the current which each conductor has to carry must be given.
7. The dielectric to be employed must be described, with its specific insulation, in terms of a quadrant-cube of gutta-percha at 75°, which is taken as unity.*
8. The thickness of dielectric must be given for the different sized conductors used.
9. The various modes of preserving and protecting the insulated cables must be given.
10. Every coil should have attached to it the maker's certificate, testifying that it complies with this specification, and that it has been tested under water.*

TESTING.

There are upwards of 130,000 miles of cables submerged in the ocean, and I cannot recall to mind a single fault that has occurred since 1865 through a manufacturer's defect that has escaped the probe of the tester. Every cable is most rigidly and carefully tested under water. Why do not users do the same with their electric light conductors? It would be the greatest safeguard for security.

There is a widespread impression that the insulation varies inversely with the potential differences employed, and that the higher the voltage used the more accurate the result. This is a mistaken notion. The following experiment was made to show its fallacy:—

TABLE SHOWING RESULTS OF INSULATION TESTS OF GUTTA-PERCHA CORE WITH VARIOUS VOLTAGES.

Number of cells. (Leclanché.)	Galvanometer readings.			Insulation after 1 minute's electrification.
	1st min.	2nd min.	3rd min.	
				Megohms.
10	18½	16	14½	164·3
40	76	67	64	162·2
100	179	163	157	173·3
200	181 7,000 ω	168	162	168·2
300	192 4,000 ω	181	177	172·2
400	188 3,000 ω	177	173	174·1

The advantage of high voltage is that it breaks down incipient faults; but, on the other hand, if too high, it may put in faults; it is therefore advisable that the insulation be tested with a voltage, say, not less than 50 per cent., and not more than 100 per cent. above the voltage it is intended to resist.

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* This can easily be deduced from its insulation in megohms per mile when the dimensions and the temperature coefficient for the material are given.

* Messrs. W. Glover and the Silvertown Company already do this.

[Errata.—Page 675, for

$$\sigma = \frac{\rho\, l\, 2\, \pi}{\log_\epsilon \frac{D}{d}},$$

where ρ is the specific resistance in C.G.S. units . . . .

read,

$$\sigma = \frac{R'\, l\, 2\, \pi}{\log_\epsilon \frac{D}{d}},$$

where R' is the resistance in C.G.S. units . . . .

For "ρ" in the note—* A simple approximation . . . —substitute "R'."]

THE ELECTRIC LIGHTING OF BRUSSELS.

The conditions applicable to the above installation of the electric light, for which three London and three foreign firms have sent in tenders—as set forth in the specification signed by M. Buls, are most stringent in character. This specification consists of 28 articles. Article 1 explains the object of the undertaking; while the second states that entire liberty is allowed contractors as to choice of system. Article 3 refers to the position set apart for the works; 4, to the power of the installations; and 5, to private lighting. 6 and 7 are unimportant; while 8 has reference to the boilers to be used; 9, to the foundations of the engines; 10, to the dynamos, their foundations, working, and lubrication; 11, to accumulators; and 12, to transformers. Article 15 is devoted to the subject of canalisation; 16 and 17, to price; and 18, to the cost of working, which will be specially verified during the two years of working mentioned in Article 22. The following articles give details as to the commencement of the works, the carrying out of them, their provisional reception; and (Article 22), the provision of a working staff by the contractor, for which 20,000 francs will be allowed when the works are definitively taken over by the authorities. Article 23 has relation to the taking possession by the College; 24, to guarantees; 25, to the amount of security to be lodged (10 per cent. of the contract sum); and 26, to the mode of payment, which will be as follows:—70 per cent. of the cost of the works on provisional reception; 15 per cent. a year later, the balance to become payable on the definite taking over. All the working expenses during the two trial years to be paid monthly. Article 27 refers to infractions of the specification; and 28, to miscellaneous arrangements. The College, which is still studying the question, is expected to shortly give its decision as to which tender it has accepted.

FRENCH ELECTRICAL NOTES.

A large crowd assembled to witness the opening of the new Popp station on the Quai de la Gare (to which we briefly referred last week). The Minister for War and the Governor of Paris were represented by Colonel Lanouvelle, while a large number of engineers, &c., were also present. At 3 o'clock M. Popp, surrounded by the directors, made a speech, in which he thanked M. Joseph Leclaire for his assistance in the installation. M. Nicolas, representing the Minister of Commerce, spoke of the success achieved by the Popp Company, and also assured it of the sympathy of the Government. M. Popp afterwards showed those present all the details of the installation, and afterwards, at an improvised buffet, a toast was drunk to the prosperity of the company.

The Syndical Chamber of Cattle Commissioners has just presented the following petition to the President of the Paris Municipal Council:—"We have heard that the authorities of Paris are at the present moment considering the system of lighting by electricity between the Pont de Cinnée and the fortifications along the canal, one part of which cuts through the centre of the abattoirs and cattle market. As there have already been numerous complaints on the absolutely defective lighting of these two establishments, and as several demands tending to lighting by the electric light have been formulated by municipal councillors, would it not be possible to make them both profit by the measure about to be applied to the quays on the canal? We submit this resolution to you in the form of a petition, and we are persuaded that you will submit it to the Municipal Council of Paris and support it with your high influence." The petition was sent to the Second Commission.

Glasgow Electric Lighting.—At a recent meeting of the Glasgow Town Council, it was resolved that the minutes of the Gas Committee, including those of the Sub-Committee on Electric Lighting, which recommended the adoption of the low-tension system, be adopted. There was a good deal of discussion on the matter, and an amendment to the above resolution was proposed, but in the end the minutes were adopted without any amendment by a very large majority.

NOTES.

Long-Distance Telephony.—It is said that Prof. L. V. Blake and Mr. E. W. Caldwell, of the University at Lawrence, Kan., U.S.A., have invented a new long-distance telephone.

Underground Electric Tramway in Paris.—It is proposed, says a Paris correspondent of the *Financial Times*, to construct an underground electric tramway between the Place Chateaudun and the Rue Marcadet. The principal stations would be near the College Rollin and at the Church of the Sacred Heart.

Palace Electric Lighting.—From the *World* we understand that the restored Palace of Laeken, illuminated from end to end with electric light, will be reopened, on or about the 20th inst., with a Parliamentary banquet of 150 covers. The works are now being pushed forward day and night as rapidly as possible, under the personal superintendence of the King and Queen of the Belgians.

The South Australia Postmaster-General's Jubilee.—A correspondent of the *St. James's Gazette* states that a private cable message received from Adelaide announces that Mr. Charles Todd, C.M.G., M.A., F.R.S., Postmaster-General, Superintendent of Telegraphs, and Government Astronomer of South Australia, has just celebrated the jubilee of his official service.

Chicago Exhibition, 1893.—Her Majesty, by order in council, has been pleased to declare that the conditions of the patent act, 1883, under which an application for a patent is not to be invalidated by the exhibition of an invention at an International Exhibition, are to apply to the Chicago Exhibition, and also that exhibitors are to be relieved from the conditions of the above act, under which they were required to give notice to the Comptroller of patents of their intention to exhibit the article afterwards sought to be patented. The regulations also apply to designs intended to be registered. We hear that Reuter's Telegram Company, Limited, have been appointed sole agents to the Columbian World's Fair at Chicago in 1893 for the purpose of publicity for Europe and the British colonies.

Electric Transmission of Power.—A Belgian writer, in commenting on the long-distance transmissibility of electric power, asks whether the transportation of coal from the districts of Charleroi, Mons, and Liège could not with advantage be greatly reduced, and in its place large electric generating stations erected near the coal mines, so that the coal intended for use in power production in various parts of the country could be used on the spot, and the power obtained transmitted as electricity over cables to the required district? Should this proposal of transmitting power over long distance come generally to pass, together with the gas-pipe line which was suggested in one of our contemporaries a short time ago, the dweller in industrial towns seems to have every prospect in store of once more enjoying a breath of fresh air, and seeing the great smoke question settled.

"Going into Business."—Our contemporary, *Electrical Plant*, in the current issue, publishes a letter on this subject from a correspondent, who ventures to assert that the opinions offered by them are open to grave doubt as to one or two of the conclusions arrived at. Our contemporary, referring to the letter, states that they know from their journalistic experience that it is a subject upon which very different views are taken by persons who regard the subject from different standpoints. The letter is doubtless of interest, but *Electrical Plant* say that so far as they personally are concerned they would endeavour to discourage young men from setting up in business as manufacturers unless they have a very large capital at their back; this, of course, applies to the attempt of the "small man" to enter into useful competition with the "large manufacturing houses." We quite agree with our contemporary.

Traffic on U.S. Electric Tramways.—During the first six months the electric tramway was in use at Washington, Pa., U.S.A., 155,000 passengers were carried.

New Telegraphic Cable in Japan.—The new cable between Echigo and Sado Island, Japan, was opened for public service in October last.

The Electric Light in German Coal Mines.—A trial was recently made in lighting the Dudweiler mine, in Germany, electrically. Twenty arc lamps were used at the trial, which was very successful.

Lecture.—A lecture on "Electricity and its Uses" was delivered on Wednesday, the 9th inst., at the Whitgift Grammar School, Croydon, by Mr. W. Perren Maycock, M.I.E.E. An exhibition of apparatus was held afterwards, in actual working, much of which was made by the students of the Grammar School Electric Engineering Class.

Obituary.—The Spanish Telegraph Administration has lately sustained a great loss in the death of D. Julian Alonso Prados. Mr. Prados was an upright, energetic official, who had earned the respect and affection of his colleagues in the administration, as well as of others who have had the good fortune of knowing him. He joined the telegraph service of Spain in 1857, and served in various grades from sub-director to inspector-general. When any commission of importance was formed for duty at home or abroad Alonso Prados was generally a member; he had much to do with the establishment and extension of the Hughes system in Spain. Unfortunately Government organisation, by averaging things down, stifles individuality, and men like Alonso Prados are not seen at their best when in such employment. Be this as it may, the personal qualities which endeared Prados to his many friends were untrammelled, and gained him deservedly high esteem from all. Mr. Prados was a member of the Institution of Electrical Engineers.

Institution of Electrical Engineers.—At the annual general meeting of the Institution of Electrical Engineers, held on the 11th inst., the following members of council were elected for the year 1892 :—

President.

Prof. W. E. Ayrton, F.R.S., President Phys. Soc.

Vice-Presidents.

Alexander Siemens.
R. E. Crompton, M.Inst.C.E.
Sir David Salomons, Bart, M.A.
Sir Henry Mance, C.I.E., M.Inst.C.E.

Members of Council remaining in Office.

Major G. W. Addison, R.E.
Sir Albert J. L. Cappel, K.C.I.E.
Sir James Douglass, F.R.S.
Prof. J. A. Fleming, M.A., D.Sc.
Prof. Geo. Forbes, F.R.SS.(L. & E.)
Colonel R. Raynsford Jackson.
W. M. Mordey.
Prof. Silvanus P. Thompson, B.A., D.Sc., F.R.S.

New Members of Council.

Edward Hopkinson, M.A., D.Sc., M.Inst.C.E.
Prof. John Perry, D.Sc., F.R.S.
Prof. A. B. W. Kennedy, F.R.S., M.Inst.C.E.
James Swinburne.

Associate Members of Council.

Captain L. A. Beaumont, R.N.
M. Cooper.
Captain W. C. Hussey, R.E.

The Institution Premium had been awarded to Messrs. C. G. Lamb, E. W. Smith, and M. W. Woods, for their paper on "The Working Efficiency of Secondary Cells," read by them in conjunction with Prof. Ayrton; the Paris Electrical Exhibition Premium to Mr. J. Swinburne for his paper on "Transformer Distribution;" and the Fahie Premium to Mr. P. V. Luke for his communication on the "Early History of the Telegraph in India." The annual report (read by the Secretary, Mr. F. H. Webb) congratulated the society on the satisfactory character of the same, and added that the number of members elected during the past year was greater than in almost any previous year. It was announced that Prof. Nikola Tesla is on his way to England, and had promised to lecture on his high-frequency experiments before the Institution in January next, and that the council would spare no pains to ensure that the lecture should be thoroughly well experimentally illustrated.

New Aluminium Boat.—A life boat, constructed of aluminium, has just been finished at Stralsund, in Pomerania. It is intended for experimental use by the Imperial Marine Department, and owing to its lightness it is expected to yield good results.

The Electric Lighting of Leeds Town Hall.—In the course of an enquiry last Friday by the Sub-Corporate Property (Town Hall) Committee of the Leeds Corporation as to the unreliability of the electric lighting arrangements at the Town Hall and Municipal Buildings, it was stated, says the *Yorkshire Evening Post*, that one of the causes is the unsuitability for its purpose of the coal supplied for the generating engines. The chairman was authorised to obtain a different class of fuel if necessary. It also transpired that the present engine boilers are becoming unfit for the purpose, and that all the existing electric lighting apparatus may before long have to be removed from the cellars of the municipal offices to other quarters. On Friday the attendants were at work in a temperature of 90°, and the chimney which carries off fumes and smoke is said to have been alarmingly weakened by heat.

The Telephone System.—At the Plymouth Chamber of Commerce last week a resolution was proposed for the Associated Chambers to consider, declaring "that it is desirable for the development of the telephone system of this country that the Government be asked to take it over, provided satisfactory assurances can be obtained that the Government officials are prepared to work the system and extend it with vigour and efficiency." It was urged that the telephone system of the country was becoming too large for private companies to control, and that such companies had been brought almost to a deadlock. Their capital was absorbed, and they were unable to provide the double wires and other appliances which electricians told them must be adopted to make the system a complete success. The resolution was agreed to.

The South Staffordshire Tramway Company.—At the monthly meeting of the Wednesbury Town Council, the Sanitary Committee recommended that the application of the South Staffordshire Tramway Company for an extension of time for the use of steam pending the substitution of electricity for steam power be granted subject to the company paying or incurring the payment within three months of the sum of £500, payable in respect of an improvement in Lower High Street. The Mayor, in moving the adoption of the report, said the Tramway Company was taking steps to substitute electricity for steam on the lines between Wednesbury, Walsall, and Bloxwich, but the poles were not yet erected on which it was proposed to carry the electric current, and it was important that the application should be granted, so as not to interfere with the traffic and inconvenience the public. Mr. Handley seconded the motion, which was carried.

Overhead Wires.—Mr. Crompton writes :—"The trade have to thank you for your article on overhead lines in your number of December 11th. You ask whether it is seriously intended that the Board of Trade should prohibit all overhead lines in the future. I answer, yes. The Board of Trade deliberately wrote to my firm, among others, using the words that overhead conductors can only be used as a temporary arrangement, and that all permanent conductors must be laid underground. This can only be read as to mean that the Board of Trade's wish is to absolutely prohibit the use of overhead wires for electric lighting or transmission power purposes. In your last paragraph you point out that even if the Board of Trade allow overhead wires, they may make their use prohibitive by regulations too stringent in their nature, and this is actually the case. It was my wish to make the present memorial in such form that we might not only have the use of overhead wires sanctioned, but the existing rules for their use somewhat modified. We were advised at the Chamber of Commerce that it would be better to first get up as strong a memorial as possible to prevent the absolute prohibitive action I have mentioned, and to get a second memorial to the council of the Institution of Electrical Engineers, so that the rule as to insulation, &c., might be more carefully considered."

Glasgow City Hall Lighting.—We learn from the *Glasgow Evening News* that the incandescent electric light is to be used in future in the City Hall instead of the arc.

The Sheffield Telephone Company.—On Saturday evening last the new switch-room at the offices of the Sheffield Telephone Exchange and Electric Light Company, in Commercial Street, was opened.

Hobart Tramways and Electricity.—The tramways of the city of Hobart, Tasmania, which have recently been purchased by a London syndicate, are in future to be worked by electricity.

The Electric Light in Bombay.—The electric light in Bombay has been recently increased by an installation at Admiralty House. The work has been carried out by Messrs. Volkart Brothers, the Bombay agents of Messrs. Ganz & Co., of Budapest.

Telegraph Tariffs.—From the *Financial News* we understand that Mr. Henniker Heaton, M.P., says that he intends to give Sir John Pender no rest until the rates for cablegrams between England and Australia are reduced to 1s. per word. He thinks that twice the amount of money might be earned if the reduction were effected.

Electricity and Mechanics in Mechanical Engineering.—A Conference is to be held at Toynbee Hall, 28, Commercial Street, E., to-day to consider how classes in electricity and mechanics can be made more useful to artisans engaged in mechanical engineering. Mr. W. P. Preece will open the discussion.

Electric Light and the Eyesight.—The letter which we publish from Mr. Waterhouse is one of considerable importance, as what he says may, in the hands of eloquent canvassers be used greatly to the detriment of incandescent lighting by alternating currents. The frequency of alternations is so great compared with the number of impulses which are supposed to make an impression of continuity upon the eye that the subject seems to be one for decisive and exhaustive experiments.

The Theatrephone.—M. Szarvady, the joint patentee with M. Marinovitch, exhibited the "Theatrephone" at the Savoy Hotel last Friday. We have referred in a previous issue to the capabilities of this instrument. Suffice to say that connected with the Savoy Theatre, the *Nautch Girl* was most distinctly heard. We understand that the demonstration was for the benefit of the National Telephone Company, with whom negotiations are pending for the introduction of the instrument into England.

The City of London Electric Lighting Company.—This company has appointed Mr. David Cook, late superintending and consulting electrical engineer to the Corporation of Glasgow, as general manager. The supply of current to private consumers was commenced on Monday last from the company's central station at Meredith's Wharf. The Mansion House is being supplied with light throughout, and the company is now prepared to connect consumers on both sides of Queen Victoria Street (eastern end), and expects to be able to connect those in the western end of Queen Victoria Street early in 1892.

The Elmore Copper Companies.—A letter appeared in the *Financial News* of yesterday, from a "confiding investor" in this company, who thinks the company has been remarkably silent about its operations of late. Although the financial year of the company ends in June, yet he has not received a copy of the accounts, and no meeting has been called. He contrasts the company's actions this year with those of last year, as the accounts ending June 30th were audited and presented to a meeting in July. He trusts the rumour that no dividend is forthcoming has nothing to do with this delay. The poor fellow invested in the company's shares on the strength of Mr. W. Elmore's famous prophecy: "I now predict that at no very distant period the shares will stand at £50, instead of their present price." They are not now saleable at £3.

Eastern Telegraph Company, Limited.—The Eastern Telegraph Company, Limited, notify the restoration of telegraphic communication with South Africa by the west coast route.

Football.—An interesting Rugby football match will take place to-morrow between the electrical staffs of the Silvertown Telegraph Works and Siemens Brothers. Ground—Fairfield, Old Charlton. Kick off 2.45 p.m.

The Lighting of Helston.—The resolution passed on October 14th, authorising the council to apply for a provisional order for the lighting of the borough by electricity was rescinded at a special meeting of the council on Thursday evening.

Electricity.—At a meeting of a South Wales Debating Society, held last week, one of the members (Mr. J. R. G. Daniels) read a practical and interesting paper on "Electricity: The Motive Power of the Future," in which he pointed out the progress electricity was making in all parts of Wales.

The Mansion House Lighting.—The *Times* states that on Wednesday last the work of installation of the electric light into the Mansion House, which has occupied the last five weeks, was finally completed. The Planet Electric Lighting Company carried out the tender for the work.

Electric Safety Lamps for Miners.—We notice that a Welsh newspaper has taken up the subject of colliers' safety lamps; and, on the grounds that the present lamps are neither suitable or safe for the purpose to which they are put, advocates the adoption of an electric safety lamp for miners.

Country House Lighting.—It has been decided to light Callaly Castle, Northumberland, throughout with the electric light, and the work has been entrusted to Messrs. Drake and Gorham, and is proceeding as rapidly as possible. There will be 2 Cornish boilers and 2 engines and a total of about 350 lights.

A New Incandescent Lamp.—According to the New York *Electrical Engineer*, the Pennsylvania Electric Engineering Company, of Philadephia, is introducing a new incandescent lamp, which is exhausted by a metallic pump, which is capable of producing fine attenuations for incandescent lamp work.

Trial of the Sims-Edison Torpedo.—The *Financial Times* states that a trial of the Sims-Edison electrically controlled dirigible torpedo was made on Tuesday last on the Tyne at Newcastle before Sir William G. Armstrong, Mitchell and Co. An exhibition will shortly be given before the Lords of the Admiralty at Stokes Bay.

Brighton and Hove Electric Light Company, Limited.—We would draw special attention to the copy of this company's debenture prospectus which was issued last Saturday, and which appears in our "City Notes" and also amongst our advertisements. The subscriptions must be received *not later* than to-morrow the 19th inst.

City and Guilds of London Institute.—The Lord Mayor presided last Monday night at the annual distribution of prizes and certificates to the pupils of the City and Guilds of London Institute, at the Salters' Hall, St. Swithin's Lane, E.C. The awards were presented by Sir Geo. B. Bruce, past president of the Institution of Civil Engineers.

Electric Lighting at Plymouth.—At a meeting of the Town Council last week a motion was carried to the effect "that it be referred to the Works Committee to consider and report to the council upon the desirability or otherwise of obtaining powers for lighting the borough by electricity, and that they confer with the Water Committee as to whether water power could be made available for generating electricity." An opinion was expressed that the Plymouth Council could carry out a system of electric lighting more cheaply than almost any other corporation in the kingdom, because there was such an abundant water supply.

NEW COMPANIES REGISTERED.

Chloride Electrical Storage Syndicate, Limited.—Capital, £262,500 divided into 250,000 £1 ten per cent. preference shares, and 12,500 £1 founders' shares. Objects: to adopt a provisional agreement dated November 30th, 1891, and made between the Electric Storage Battery Company, and the United Gas Improvement Company, of the one part, and Mr. J. A. E. Hickson (on behalf of this company), of the other part, for the sale to and purchase by this company of certain business patents and other property; to work such patents; to carry on the business of an electric lighting company in all or any of its branches; to carry on the business of iron masters, copper smelters, iron founders, boiler makers, electricians, electrical contractors, electrical and mechanical engineers and suppliers of electricity in all or any of their branches. Signatories (with 1 share each): J. E. Yeates, 9, Solent Crescent, West Hampstead; W. J. Torney, 24, Granard Road, Wandsworth Common, S.W.; S. S. P. Cooke, 53, Chadwick Road, Peckham; H. J. Rumball, 16, Ruvigney Road, Putney; F. B. Liley, 58, Sandmere Road, Clapham, S.W.; S. S. Ludlow, 34, Werter Road, Putney, S.W.; E. J. Newbatt, 57, Cowley Road, North Brixton, S.W. The number of directors is not to be less than 3 nor more than 9, the first to be elected by the subscribers, subject to the right reserved by the vendor to nominate one-third of the board. Qualification: 500 preference shares. Remuneration: £1,500 per annum, divided as they themselves or the company determine. Registered on the 12th inst. by Hays, Schmettau & Co., 31, Abchurch Lane, E.C.

California Gas, Water, and Electric Light Company Syndicate, Limited.—Capital, £2,000 in £1 shares. Objects: to adopt and carry into effect agreements for the acquisition of any gas, water, or electric lighting works, or businesses in the United States of America, Canada and the colonies of Great Britain, and to carry on such works. Signatories (with one share each), G. B. B. Paton, 20, Bucklersbury, E.C.; F. Vernon, 67, West Croxted Road, West Dulwich; E. P. Smith, Hollywood, Lewisham Hill, S.E.; C. C. Bowes, 48, Eyot Gardens, St. Peter's Square, W.; J. Viney, 6, Dunster Gardens, N.W.; Miss A. A. Hopewell, 28, Ridge Road, Stroud Green, N.; G. Parker, Stanthorpe, Bexley Heath. The regulations of Table A mainly apply. Registered on the 10th inst. by Oldfield, Barham and Oldfield, St. Stephen's Chambers, Telegraph Street, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

County of London Electric Lighting Company, Limited.—The statutory return of this company, made up to the 30th ult., was filed on the 7th inst. The nominal capital is £100,000 in £5 shares, 200 of which have been taken up, £1 called upon each, and £190 paid, leaving £10 unpaid. Registered office, 1, Great Winchester Street, E.C.

Electrical Assets Purchase Company, Limited.—The statutory return of this company, made up to the 23rd ult., was filed on the same day. The nominal capital is £1,000 in £1 shares, of which 564 have been taken up. The full amount called and paid on 64, and the remaining 500 considered as fully paid. Registered office, 19, Eastcheap, E.C.

Electric Lighting Company, Limited.—The following was filed on the 8th inst. To the Registrar of Joint Stock Companies:—Dear Sir,—I beg to inform you that a general meeting of the above-named company was held at my offices, No. 1, Queen Victoria Street, E.C., on Thursday, November 26th last, in accordance with Section 142 of the Companies Act 1862, at which meeting an account was submitted, showing the manner in which the winding up had been conducted and the property of the company disposed of. Robert A. McLean, liquidator.

"Energy" Gas Electric Lighting and Power Syndicate, Limited.—The statutory return of this company, made up to the 10th inst., was filed on the same day. The nominal capital was £20,000 in £1 shares. Only seven shares are taken up, upon which nothing has been called. Office, 5, Chancery Lane, W.C.

Epstein Electric Accumulator Company, Limited.—The statutory return of this company, made up to the 1st inst. was filed on the 10th inst. The nominal capital is £101,000 divided into 100,000 ordinary and 1,000 founders' shares of £1 each. All the founders' and 70,207 of the ordinary shares are taken up, and upon 200 ordinary 5s. per share has been called and paid. The remaining 1,000 founders' and 70,007 ordinary shares have been issued as fully paid. Office, 34, Cannon Street, E.C.

Italian Electrical Light and Power Company, Limited.—The statutory return of this company, made up to the 30th ult., was filed on the 7th inst. The nominal capital is £60,000 in £4 shares. 307 shares have been taken up, 300 of which have been issued as fully paid. The remaining 7 have had nothing called upon them. Office, 10, Austin Friars, E.C.

Venezuela Telephone and Electrical Appliances Company, Limited.—The annual return of this company, made up to the 4th inst., was filed on the 11th inst. The nominal capital is £70,000 in £1 shares, all of which are taken up, 56,506 have been issued as fully paid, while upon the remainder the full amounts have been called and paid. Office, 37, Lombard Street, E.C.

Wolverhampton Electric Light and Power Company, Limited.—The annual return of this company made up to the 18th February last was filed on the 10th inst. The nominal capital is £50,000 in £10 shares, 23 of which have been taken up, the full amount called and all calls paid. Office, Wolverhampton.

BUSINESS NOTICES, &c.

The Telegraph Manufacturing Company, Limited.—We have received from the Telegraph Manufacturing Company a copy of their new price list of electric light cables. The list contains data on the lines of the suggestions offered in Mr. W. H. Preece's paper. The sheet forms one of half a dozen, and in other sheets which the company intend issuing they will state prices separately of underground mains and concentrics, in which naturally the insulation resistance per mile will decrease as the conductor increases in size. We have pleasure in recommending these lists to the attention of our readers.

Rapid Electric Lighting.—Some very quick work has been recently carried out at the French Gallery, Pall Mall, by Messrs. Frank Suter & Co., 66, Berner's Street, W. This firm commenced work on Friday evening the 11th inst., at 5 o'clock, and had entirely completed the installation of their system of picture lighting by 10 o'clock the following morning. We understand that the system adopted is similar to that employed by the same firm in lighting the galleries of Messrs. Tooth's, Messrs. Maclean's and Messrs. Dowdeswell's.

Charlesworth, Hall & Co.—This firm have lately published a revised price list of dynamos, splendidly illustrated. Particulars, prices and illustrations of their search light projectors and machinery, lamps, holders, switches, instruments, &c., arc lamps, arc light carbons, wires and cables, also their patent electric fire alarm, and crank engines, are given very fully. We have pleasure in recommending this catalogue.

Tender Wanted—Ennis.—The Ennis Town Commissioners invite specifications and tenders for the public and private lighting of the town of Ennis by electricity. Such specifications and proposals to be sent to Mr. Ernest Miniken, Town Clerk, Town Hall, Ennis, by January 1st. All expenses and costs incurred in the preparation of the said specifications and tenders to be borne by the parties sending in same.

Woodhouse and Rawson.—We have received from Messrs. Woodhouse and Rawson a copy of their List B, Section 5 catalogue of electrical machinery and apparatus connected therewith. This section contains illustrations and prices of brackets, electroliers, shades, &c., and should meet the requirements of the electrical trade generally.

Liverpool Electric Supply Company.—We understand that this firm have just completed a splendid electric lighting installation at the Adelphi Hotel, Liverpool. The work was carried out under the supervision of Mr. Holmes, managing director of the company.

Munro Electrical Manufacturing Company. Limited.—This firm have opened show rooms at 17, Princes Street, Hanover Square, W., where they will continue to be represented by Messrs. H. W. Hooper & Co.

V. Choutard and Christensen.—This firm have just brought out a new type of electrical machine of the Wimshurst system. The chief feature in this machine is, that it will produce an electric current of such power as has only been achieved hitherto by machines almost double in size and consequently double in price.

CITY NOTES.

The Electric Construction Corporation, Limited.

In submitting the accounts of the corporation up to September 30th last, the directors point out that the period embraced by the previous profit and loss account extended over nearly 16 months, whereas the present report only includes the working at Wolverhampton for one year, and at the Millwall works for eight months.

The directors are happy to state that the business of the year has been of a satisfactory and promising character, and it will be seen from the accompanying accounts that it has resulted in a profit balance of £46,166 16s. 8d., from which the directors have carried £10,000 to reserve for depreciation, leaving a net balance of profit and loss for the year of £36,166 16s. 8d., which, with the £3,877 11s. 1d. carried forward from last year, makes a total of £40,044 7s. 9d. available for disposal.

The development of the electro-chemical patents of the corporation is advancing to the satisfaction of the directors, and a substantial addition to future profits may be expected from this source. As the shareholders are already aware, Mr. Ebbsmith has resigned his appointment as managing director of this corporation in order to take charge of the British Electro-Chemical Agency, Limited, to which these patents have been transferred, but in order that the corporation might not be deprived of the benefit of his experience, he has been elected to fill the vacancy on the board caused by the lamented death of Sir Robert Fowler.

The directors have leased the Millwall works on favourable terms to the Electrical Power Storage Company, Limited, with an exclusive license to that company to use the storage battery patents belonging to the corporation. This arrangement has already proved of great advantage to both parties, and it has the further merit of enabling the manager and chief engineer, Mr. Parker, to concentrate his energies on the important contracts and work which the Wolverhampton works have in hand.

In continuance of their previous policy, as approved by the shareholders at the last general meeting, the directors have written off capital expenditure the sum of £20,000 out of the sale of the patents sold or transferred to other companies during the past year. The sale of these patents will not in any way prejudice the working of the corporation; on the contrary, it is confidently expected that their development will bring a considerable amount of work to the factory at Wolverhampton.

The directors have pleasure in recommending a dividend of 6 per cent., payable on January 22nd next, leaving a balance of £10,721 19s. 4d. to be carried forward to the present year's account.

The prospects of business are very satisfactory. The corporation is at present carrying out, in addition to ordinary work, large and important contracts for the Liverpool Overhead Railway, the electric lighting of the City of Oxford, and also for the electrical plant for the Crystal Palace district.

The balance of the authorised debenture issue is now required for the working of the corporation, and the directors will be glad to receive applications, as soon as possible, on the enclosed form, in order to avoid the expense of a public issue.

In accordance with the articles of association, four of the directors, viz.:—Sir Henry Mance, with Messrs. Ebbsmith, Holt and Moseley, retire from the board, all of whom are eligible and offer themselves for re-election.

Messrs. Broads, Paterson & Co., the present auditors of the corporation, retire and offer themselves for re-election.

In conclusion the directors desire to express their continued and increased confidence in the future of the undertaking.

Profit and Loss Account, from October 1st, 1890, to September 30th, 1891.

Dr.				£	s.	d.
To Expenses and cost of production during the year ended September 30th, 1891, at Wolverhampton and Millwall, including engineering department and laboratory expenses				129,890	16	10
„ Depreciation of machinery, furniture, &c.... ...				3,099	18	8
„ Head office expenses, including rents, patent expenses, directors' fees, managing directors' salary, accountancy, &c.				11,423	7	1
„ Auditors' fee				105	0	0
„ Interest upon debentures and temporary loans ...				3,949	12	10
„ Other expenses, including the cost of advertising, issuing debentures, law charges, &c.				13,968	16	0
„ Balance—						
Carried to reserve for depreciation	£10,000	0	0			
Carried to balance sheet ...	36,166	16	8			
				46,166	16	8
				£208,604	8	1

Cr.	£	s.	d.
By Sales and work executed during the year ended September 30th, 1891	160,036	5	9
„ Cash and shares for licenses granted, patents sold and profits upon formation of subsidiary companies, less estimated amount applicable to capital account (£20,000)	44,710	0	0
„ Transfer fees, rents received and miscellaneous receipts	3,858	2	4
	£208,604	8	1

Balance Sheet, September 30th, 1891.

Dr.		£	s.	d.
To Capital:—				
„ 49,000 ordinary shares of £10 each, and 100 founders' shares of £10 each, less calls in arrear (£8,158 19s. 5d.)		491,841	0	7
„ 690 first mortgage debentures of £100 each ...		69,000	0	0
„ Liabilities:—				
Trade accounts, law charges, &c.		16,849	5	10
Loans		32,945	6	5
Interest accrued on debentures		1,925	16	7
Directors		1,419	9	9
„ Contingent Liabilities:—				
On pending contracts and in shares partly paid up and bills receivable discounted	£90,000			
„ Reserve for depreciation, &c., plus added this year (£10,000)		25,000	9	0
„ Profit and Loss Account:—				
Balance as per statement to September 30th, 1890 (deduct reserve, £15,000; dividend, £29,413 4s. 7d.)		3,877	11	1
Balance of profit and loss for the year as above		36,166	16	8
		£679,025	6	11

Cr.	£	s.	d.
By Purchase of the works, businesses, and patents of Elwell-Parker, Limited, of Wolverhampton and of the Electrical Power Storage Company, Limited, of London, patent rights, &c., according to last balance sheet, less depreciation of machinery, &c., (£3,099 18s. 8d.), and transfer from profit and loss account (£20,000)	289,716	17	9
„ Expenditure since—			
Land and buildings at Bushbury, new works, Wolverhampton...	13,621	19	5
Plant and machinery, &c....	10,684	8	10
Furniture, fixtures, &c.	824	2	4
	314,847	8	4
„ Shares in subsidiary companies at par, shares included in the original purchase at nominal value, and debts due by subsidiary companies ...	241,123	7	6
„ Book debts—			
Wolverhampton, Millwall, and head offices ...	64,001	11	0
„ Stocks at Wolverhampton and Millwall	31,966	13	10
„ Cash at Bankers	13,994	11	8
„ Bills in hand	13,091	14	7
	£679,025	6	11

We have examined the above balance sheet, with the books, vouchers and accounts of the Electric Construction Corporation, Limited, and consider that it correctly shows the financial position of the Corporation as on September 30th, 1891. Although the shares, &c., stand at £241,123 7s. 6d. the £120,000 written off capital expenditure, in effect is a reserve against this item. We think £10,000 a proper sum to add to reserve account for depreciation, &c.

Broads, Paterson & Co., *Auditors.*

1, Walbrook, E.C., London,
November 30*th*, 1891.

The Fowler-Waring Cables Company, Limited.

In submitting their second annual report, the directors of this company express their regret that they are unable to show a profit on the work of the year. At the same time, they are glad to say that the business of the company has made great progress. There has been a marked increase in the volume of business done as compared with last year, and the gross profit has been sufficient to cover all ordinary and some extraordinary expenses. The factory is now well equipped and organised, and the work done there is unsurpassed. Since the close of the financial year numerous orders have been received, to say nothing of many important enquiries. The directors, therefore, fully retain their previously expressed confidence in the future of the business, further details of which will be found in the annexed report of the general manager. There is, however, no manufacturing business in which the competition is keener than it is in ours, and a new undertaking must necessarily require time for development and to make its manufactures known. Meanwhile, as materials must be paid for almost on delivery, and as it is often necessary to give considerable credit to our customers, as well as to provide for special additions to plant to enable us to meet the new demands constantly being made by electrical engineers, the directors believe that the employment of a larger working capital than the company possesses would be justified by results and would materially assist in bringing the concern to a dividend-paying position. The directors have, again, not drawn their fees, but, on this occasion, they have debited the amount in suspense, as they anticipate a state of things when the payment of this amount will be fully justified by the condition of the business. The retiring directors, Mr. Walter Chamberlain and Mr. R. W. Eddison, being eligible, offer themselves for re-election. The auditors, Messrs. Cooper Brothers & Co., also offer themselves for re-election.

The General Manager's report states that during the past year the company has made notable progress in each department of its work, and their manufactures have been successfully applied and their efficiency proved in every important branch of electrical engineering. In electric lighting, among the larger orders they had delivered to the London Electric Supply Corporation 10 miles of large concentric conductors for the distribution of their high-tension currents through the streets of London. These cables are now laid, and are working daily under conditions which demand the most perfect efficiency; the best testimony to their success is the fact that the corporation have ordered an additional 10 miles to be delivered during the next few months. In ship lighting, eight of the new warships at present building for the Admiralty have been wired by cables of their manufacture, and some of the large shipbuilders have adopted them for installation on board the steamships building in their yards. In the electric lighting and transmission of power in mines the cables have been extensively used, and they contribute very greatly to the success of this difficult and important work. They have also manufactured special wire for use with the explosives employed in blasting and torpedo experiments, and for many more of the ever-increasing number of electrical applications. In telegraphy, the leading railway companies are adopting lead-covered wires for the tunnels, yards, and stations, and many miles of their cables have been so used during the past year. In telephony, the Government has employed the company's cables exclusively for the London end of the Paris telephone lines, and also for connecting up the various centres in London. Large orders have also been entrusted to them by the private telephone companies, and they are at present laying a 100-wire cable through Paris for the French Government telephone service. They have recently despatched 15 miles of similar cable to Sydney for the Government telephone service there. Only the Fowler-Waring cables will be employed for the new central station at Sydenham, which will supply electric light to the Crystal Palace during the forthcoming exhibition. Other large orders are in hand, and the prospect of future business is exceedingly good. In his last report, Mr. Alfred E. Mavor, general manager, referred to the fact that rubber-covered wires were often specified to the exclusion of all others, and that they deemed it advisable to be prepared to supply these if it became necessary. In many instances they had been able to secure the adoption of their cables in preference to those which are rubber-covered, and all the work referred to in this report has been carried out with cables manufactured under those patents and processes which are the exclusive property of the company.

The works at North Woolwich have never yet been worked to anything approaching their possible output, and consequently the company cannot yet show a profit on their work. Sufficient, however, has been done during this year to demonstrate not only the value of their manufactures and the extent and variety of their application, but to justify the firmest confidence in the future of the company.

BALANCE SHEET, September 30th, 1891.

DR.	£	s.	d.
To Capital—			
Authorised 40,000 shares of £5 each	200,000	0	0
Issued 20,000 shares £4 10s. per share paid up, and 300 founders' shares issued as fully paid to vendors, £91,500; deduct arrears of calls (£150)	91,350	0	0
„ Creditors	15,286	12	9
„ Liability on bills receivable discounted	1,657	6	2
	£106,636	12	9

CR.	£	s.	d.
By Cash—			
At Bankers and in hand	1,165	15	2
„ Debtors	13,656	0	10
„ Stock	14,011	4	2
„ Office furniture—			
In City offices and factory	515	7	3
„ Shares in other companies	25	0	0
„ Machinery and plant—			
As per last account September 30th, 1890 ...	8,977	12	2
Additions during the year	6,116	14	8
„ Works and buildings—			
At North Woolwich, as per last account, September 30th, 1890	12,907	17	1
Additions during the year	1,662	5	9
„ Patents and goodwill—			
As per last account, September 30th, 1890 ...	41,000	0	0
„ Preliminary expenses—			
As per last account, September 30th, 1890 ...	3,325	8	6
„ Profit and loss account—			
As per last account, September 30th, 1890 ...	1,764	16	2
Add loss for year ending September 30th, 1891, as per account	1,508	11	0
	£106,636	12	9

PROFIT AND LOSS ACCOUNT for the year ending September 30th, 1891.

DR.	£	s.	d.
To directors' fees (not drawn)	2,000	0	0
„ Rent, rates, and taxes	1,815	2	9
„ Office expenses and advertising	888	16	10
„ Fees on patents	186	0	0
	£4,889	19	7

CR.	£	s.	d.
By gross profit on cables, after deducting salaries and other expenses	3,377	13	7
„ Transfer fees	3	15	0
„ Balance—Loss for the year September 30th, 1891, carried to balance sheet	1,508	11	0
	£4,889	19	7

We have examined the above balance-sheet with the books, accounts and vouchers relating thereto, and find the same correct.

COOPER BROTHERS & CO., *Chartered Accountants, Auditors.*

London, *December 4th*, 1891.

Oxford Electric Company, Limited.

WE have received the following report from the Oxford Electric Company, Limited:—

On Saturday, the 12th instant, the first ordinary meeting of this company was held at the offices, 45, Broad Street, Oxford, J. Irving Courtenay, Esq., Chairman of the Company, presiding.

The notice convening the meeting having been read, J. IRVING COURTENAY, Esq., spoke as follows:—

"This is a formal meeting of the company, called in compliance with the statute within four months from the incorporation of the company, and is commonly known as the statutory meeting. There are no accounts to be presented, but the directors gladly embrace the opportunity thus afforded of explaining the position of the company, and inviting enquiry and co-operation from the shareholders and others attending the meeting. The Electric Installation and Maintenance Company obtained a provisional order, which was confirmed by Parliament August 4th, 1890, under which that company has powers to supply electricity to the whole Borough of Oxford. The directors being desirous of establishing the business as a local enterprise, have made arrangements for transferring the Parliamentary powers to the Oxford Electric Company, Limited, and the necessary formalities are being carried out for obtaining the consent of the Board of Trade and the Corporation of Oxford to the grant of a provisional order for the purpose. In the meantime the Oxford Company, having been duly constituted, entered into a contract with the Electric Construction Corporation, of London and Wolverhampton, by which the Oxford Company purchases all the rights under the provisional order, and provides for the construction of a fully-equipped generating station for the supply of electricity, together with all necessary street works, mains, transformers and storage batteries, for the supply of an important area which it is first proposed to deal with. This area comprises High Street, Cornmarket Street, Broad Street, Magdalen Street (from the corner of Beaumont Street to Cornmarket Street), and Catherine Street. The area in question, bounded by the streets named, comprises 12 colleges, 39 public buildings and churches, 9 hotels, and 337 shops, offices, and private houses. Provision is made in the contract for a supply of electricity sufficient for about 15,000 lamps actually connected with the company's mains. The contract provides for the purchase of the lease of the land at Osney, formerly known as Cannon Wharf—the construction of the building, of which drawings may be seen on the walls—the generating and distributing plant—the cost of incorporating this company and obtaining a transfer of the provisional order—a supply of lamps, wire, fittings, &c.—to the value of £500, and a sum of £1,500 for the ordinary expenses of the company. In the contract, the deposit of £1,500 as security paid to the Board of Trade is also provided for, but will be repaid to the contractors on satisfaction of the provisions of the order. Under this contract an agreement has been made for the erection of the generating station with Mr. Kingerlee, the well-known local builder and contractor, who is pushing on the work vigorously, and expects to have all completed by March. During the construction of the building the mains will be laid throughout the compulsory area, so that a supply of electricity will be furnished with all possible speed. The consideration for all these works and payments, including the provisional order, is a sum of £50,500, payable in fully paid up shares of the company. Assuming the capital expenditure to be £50,000, the commercial result of the enterprise may be estimated as follows:—

Revenue:—			
258,750 units of electricity at 8d., and rent of meters	£8,755	0	0
Expenditure:—			
Running expenses, rent, salaries, insurance, &c.	£5,200	0	0
Net income (or 7 per cent. on £50,000) ...	£3,575	0	0

The extension of the company's business to the residential district north of the City and the other important parts of the borough outside the area comprised in the above calculations, should materially add to the dividends of the company, as the capital of £50,000 includes buildings, street works, &c., capable of providing for a larger business. The cost to the consumer at 8d. per Board of Trade unit is equal to about ¼d. per lamp per hour, or, in other words, the current necessary to supply 30 10-C.P. lamps for one hour or their equivalent for a proportionate time. Owing to the facilities for economising the use of electricity, by the provision of a sufficient number of switches judiciously placed in the consumer's premises, it is found by experience that, though the relative cost of electricity at 8d. per unit, as compared with gas at 3s. per 1,000 cubic feet, appears to be higher, yet, in actual practice, the amount paid by the householder in each case would not materially differ, but when the convenience and advantages of the electric light, and its indirect economies, such as the saving in renewals of decorations and cleaning of rooms are taken into account, it is really in the long run cheaper than gas. For a city like Oxford the electric light is almost a necessity. The experience already obtained at the South Kensington Museum and the British Museum proves the value of electricity as a means of illumination for such institutions, while the absolute safety of the method of supply adopted by this company makes it specially suitable for lighting the various colleges, museums, and public buildings in the city with their priceless contents. I think a few words of explanation are necessary as to the system of electrical supply. I do not propose, however, to go into details, which have been already published, and Mr. Thomas Parker, the chief engineer of the Electric Construction Corporation, who has designed and is carrying out the installation, is here to-day, and will be ready to give any detailed explanation that may be required. The system proposed may be described as a moderate high tension continuous current of 1,000 volts, with continuous current transformers to convert to 100 volts, and secondary batteries to supply current to the lamps during the hours of minimum supply, thus allowing the generating station to be shut down entirely. The high tension continuous current will be conveyed by underground mains, which never come in contact with the houses of the consumers, the electricity delivered to the consumers being absolutely safe, steady, and its continuity secured by the use of the storage batteries. Reliable meters will be supplied to each customer, and charged for by quarterly rental, as in the existing system of gas supply. The cost of fitting premises for the electric light varies with the character of the buildings and the nature of the fittings, which may be of a simple and inexpensive character, or costly designs according to the taste of the customers. The company have already been estimating for a few buildings in this City, which may be taken as typical, and comprise—

Clarendon Press	994	16-c.p.	lamps	£1,326	1	8
Magdalen College	675	„	„	1,433	18	0
Christ Church	595	„	„	1,190	0	0
Metropolitan Bank...	45	„	„	67	10	0
Young Men's Christian Association	62	„	„	86	10	0

The wiring and fitting of ordinary premises, such as dwelling houses, shops and hotels, with simple fittings, can be very well done at the cost of 30s. per lamp; factories and similar buildings at somewhat less; colleges, museums, and similar institutions according to the condition and character of the buildings. All work of this kind is done under stringent rules framed by the fire insurance companies, and controlled also by the provisions for safety contained in the provisional order. No other method of artificial illumination can be compared with it for freedom from risk of fire, providing you have suitable fittings and a system of supply such as has been sketched out for the supply of the City of Oxford. As I have already stated, the company has made its arrangements to carry out all the necessary works without any public issue of capital, but the intention is, when the preliminary work is completed, to give the public an opportunity of subscribing to the capital, and thus the inhabitants of Oxford will be able to acquire an interest in this important local enterprise.

At the close of the Chairman's speech,

T. Parker, Esq., explained matters of detail connected with the proposed system of supply, and incidentally mentioned that Sir William Thomson and Prof. Silvanus Thompson had both recently inspected the electrical plant prepared for this installation and that at Sydenham, and highly approved of the working of the continuous current transformers, Sir William Thomson having expressed the opinion that their success would lead to the alternating current system being eventually superseded.

A strong feeling in favour of the introduction of the electric light into the colleges, museums, &c., was very generally expressed, and the prospects of the company appear to be highly satisfactory.

It was stated that the works were making rapid progress, and that the supply of electricity would be commenced early in the spring.

British Electro-Chemical Agency.

The first statutory general meeting of the British Electro-Chemical Agency, Limited, was held last week at Worcester House, Walbrook. Mr. Joseph Ebbsmith (the chairman of the company) presided.

The secretary (Mr. W. J. Caulfield) having read the notice calling the meeting,

The Chairman said that their duties would be very brief indeed. The meeting was held in accordance with the provisions of the articles of association. They did not lay before them any detailed report at this meeting, but it would perhaps be satisfactory for them to learn that the operations of the company, so far, had more than justified the expectations of the directors at the time the company was formed, and when the present shareholders were invited to subscribe. Possibly the results might be of a nature which would be very gratifying indeed to the shareholders, when the general report and balance sheet were issued. It was proposed to make up their accounts for the financial year to June 30th, 1892, but he was at liberty to disclose to them that the affairs of the company were in such a state that the directors confidently anticipated their ability to declare a satisfactory interim dividend at the expiration of the six months' working. At the present time there was no prospect of their making any call whatever. They had been fortunate enough already to deal with some of the minor interests of the company, and they were at the present time in the extremely sound and satisfactory financial position of having their capital intact, and also of having such an increment of profit as appeared to be quite sufficient for the immediate requirements of the company.

The meeting closed with a vote of thanks to the Chairman.

The Gülcher (New) Electric Light and Power Company, Limited.

A meeting of this company, is to be held to-day at Winchester House, Old Broad Street, E.C., to comply with the statute. The report states that it is the intention of the directors to move a resolution adjourning this meeting for two months, by which time the chairman, who is now on his way, will have returned from New Zealand, and will be able to furnish a full report of the results of his visit. The directors do not propose to submit the usual balance sheet to the shareholders until the above date mentioned, as the auditor informs them that it is impossible for him to deal with certain accounts affecting the New Zealand business until these accounts are furnished by the chairman in a more complete form. They are pleased to state that his visit to New Zealand has been entirely successful. During the time he has been out there, he has succeeded in obtaining Acts of Parliament for the private lighting of Wellington, Christchurch and Auckland passed through both the Upper and Lower Houses of Parliament. He has also concluded a fresh contract with the Corporation of the City of Wellington for the public lighting of that city in lieu of the existing one, and in addition to the contract for the private lighting, both of which contracts are of a satisfactory character.

The Brighton and Hove Electric Light Company, Limited.—The Brighton and Hove Electric Light Company, Limited, invite applications for £12,000 first mortgage debentures of £100 each, carrying interest at the rate of £6 per annum, "to enable the company to cope with the large increase of business that is being pressed upon it on all sides." The debentures will be a first charge upon the company's undertaking, and all its property, and will be repayable at par on January 1st, 1895, or earlier at the option of the company at £105. The notice states that the plant and machinery are fully employed, and that business is being turned away daily; also that the increased business which the company will be enabled to undertake when the new plant and works, to be provided by the money now being raised, are fully employed, will leave a considerable sum per annum for the company, after providing for the interest on the debentures. Concerning the company's application for further Parliamentary powers, the directors confidently expect that the Board of Trade will exercise the powers vested in it by Parliament, and will over-ride the opposition of the Corporation and grant to the company Parliamentary powers for that portion of Brighton (by far the larger portion) which is not served by the Corporation Electric Light Works. Applications for debentures must be made to the company's bankers by Saturday next.

Humboldt Electric Power and Mining Company, Limited.—The *London Gazette* states that a general meeting of the members of the above-named company will be held at the Great Eastern Hotel, Liverpool Street, London, E.C., on January 13th, 1892, to receive the liquidator's report, showing how the winding up of the company has been conducted, and its property disposed of, to hear any explanation that may be given by the liquidator, and to pass a resolution as to the disposal of the books, accounts, and other documents of the company.

St. James' and Pall Mall Electric Light Company, Limited.—We hear that the 10,000 new £5 preference shares recently offered to the shareholders by the directors of the St. James' and Pall Mall Electric Light Company, Limited, at 30s. premium have been largely over-subscribed. These shares were allotted on December 11th.

West Coast of America Telegraph Company, Limited.—The coupons due December 31st on the debentures of the West Coast of America Telegraph Company, Limited, will be paid by Messrs. Barclay & Co., Lombard Street. Coupons should be left three clear days for examination.

Crompton & Co., Limited.—The directors of Crompton and Co., Limited, have declared interim dividends at the rate of 7 per cent. per annum on the preference shares and 5 per cent. per annum on the ordinary shares for the half-year ending September 30th last.

The Eastern Extension Australasia and China Telegraph Company, Limited, have declared an interim dividend for the quarter ended September 30th last of 2s. 6d. per share, tax free, payable on January 15th.

European Sims-Edison Electrical Torpedo Company.—We hear that Major-General E. Harding Steward has joined the board of this company.

TRAFFIC RECEIPTS.

The City and South London Railway Company. Traffic receipts for last wee
amounted to £815.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (Dec. 10th.)	Closing Quotation. (Dec. 17th.)	Business done during week ending (Dec, 17th, 1891.)	
					Highest.	Lowest.
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	100 —103	100 —103	102½	102
1,300,980*l*	Anglo-American Telegraph, Limited	Stock	49½— 50½	50 — 51	50¾	49¾
2,849,510*l*	Do. do. 6 p. c. Preferred	Stock	87½— 88½	88 — 89	88⅝	88
2,849,510*l*	Do. do. Deferred	Stock	12¾— 13¼	13 — 13½	13 5/16	13 3/16
130,000*l*	Brazilian Submarine Telegraph, Limited	10	11 — 11½	11 — 11½	11⅜	11
53,200*l*	Do. do. 5 p. c. Bonds	100	100 —103	101 —104	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	103 —107	104 —108	...	...
77,978*l*	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3¼— 3½	3⅛— 3⅜	3 5/16	3⅛
69,996*l*	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2 — 2¼	2 — 2¼	2¼	2⅛
40,000*l*	Chili Telephone, Limited, Nos. 1 to 40,000	5	4 — 5	3½— 4½	...	...
50,000*l*	City and South London Railway, Nos. 1 to 50,000	10	3 — 5	3 — 5	...	...
30,152*l*	City of London Elec. Lighting Co., Ltd., Ord. 40,001-70,152, £4 paid	6	5 — 6	5½— 6	6 1/16	6
$7,716,000	Commercial Cable, Capital Stock	$100	145 —148	145 —148	150⅜	149½
224,850*l*	Consolidated Telephone Construction and Maintenance, Limited ..	14/-	⅜— ½	⅜— ½	...	...
20,000*l*	Crompton & Co., Ltd, 7 p. c. Preference Shares, Nos. 1 to 20,000	Stock	5¼— 5¾	5½— 6	5 11/16	5⅝
16,000*l*	Cuba Telegraph, Limited	10	10 — 11	10 — 11	...	...
6,000*l*	Do. do. 10 p. c. Preference	10	16 — 17	16 — 17	...	...
12,931*l*	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3¼— 3¾	3¼— 3¾	...	...
6,000	Do. do. 10 p. c. Preference	5	9½— 10½	9½— 10½	...	...
60,710	Direct United States Cable, Limited, 1877	20	10⅞— 11⅛	10⅞— 11⅛	11⅛	10 15/16
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14 — 14¼	14 — 14¼	14¼	14
70,000	Do. 6 p. c. Preference	10	14¾— 15¼	14¾— 15¼	15⅛	14⅞
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	107 —110	107 —110	108¾	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	106 — 109	106 — 109	107¾	106⅜
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15 — 15¼	15 — 15¼	15 3/16	14⅞
78,300*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	104 —107	104 —107	...	...
276,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	104 —107	104 —107	104½	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	107 —110	107 —110	109½	109
135,000*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	102 —105	103 —106	...	...
180,400*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	102 —105	103 —106	104½	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	99 —102	99 —102	100¾	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	6 — 7	6½— 7	7	6¼
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	1⅞— 2⅛	1⅞— 2⅛	2 1/16	2
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	2⅞— 3⅛	2¾— 3	3	2⅞
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd,	2	2 — 2¼	1⅞— 2⅛	2⅛	2
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	9¾— 10	9¾— 10	9⅞	9⅝
180,042	Do. do. 6 p. c. Preference	10	14¾— 15	14¾— 15	15	14¾
150,000	Great Northern Tel. Company of Copenhagen	10	18¾— 19¼	18¾— 19¼	19⅛	18¾
220,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105 —108	105 —108	...	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	8 — 8½	8 — 8½	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	9½— 10½	9½— 10½	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ...	10	20½— 21½	20½— 21½	21	20⅞
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	103 —105	103 —105	...	...
17,000	Indo-European Telegraph, Limited	25	41 — 43	41 — 43	...	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	5 — 6	4 — 5	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	8¾— 9¼	8¾— 9¼	...	...
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	105 —108	105 —108	107½	105½
43,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	9¾— 10¼	9¾— 10¼	10⅛	...
447,234*l*	National Telephone, Limited, Nos. 1. to 438,984	5	4⅜— 4⅝	4⅜— 4⅝xd	4 9/16	4¼
15,000	Do. 6 p. c. Cum., 1st Preference	10	12½— 13	12¼— 12¾xd	12 11/16	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	12 — 13	12 — 12½xd	...	...
420,000*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	107 —109	107 —109	108¼	107½
250,000*l*	Do. (issued at 5 p.m., all paid)	25	28 — 32	29 — 32	30½	...
6,318*l*	Notting Hill Electric Lighting Company, Limited, £8 paid ...	10	6½— 7½	6½— 7½	...	...
220,000*l*	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	3/16 — 5/16	3/16 — 5/16	¼	...
9,000*l*	Reuter's Limited	8	7¾— 8¼	7¾— 8¼	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	8¾— 9¼	8½— 9	8⅞	8¾
7,900	Do. do. do. 7 per cent. pref.	2	7¼— 7¾	7¼— 7¾	7⅝	...
3,381	Submarine Cables Trust	Cert.	115 —120	117 —122	...	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	4¼— 4¾	4¼— 4¾	4½	...
37,350	Telegraph Construction and Maintenance, Limited	12	42 — 44	42 — 44	...	...
150,000*l*	Do. do. do. 5 p. c. Bonds, red. 1894	100	102 —105	102 —105	...	...
58,000	United River Plate Telephone, Limited	5	1 — 2	1 — 2	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	85 — 95	85 — 95	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	7½— 8½	7 — 8	...	...
271,400*l*	Do. do. do. 5 p. c. Debentures	100	97 —100	97 —100	98⅝	98⅜
30,000	West Coast of America Telegraph, Limited	10	3½— 4½	3½— 4½	...	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	99 —104	100 — 105	...	...
67,007*l*	Western and Brazilian Telegraph, Limited	15	10¼— 10¾	10¼— 10¾	10⅝	10¼
30,364*l*	Do. do. do. 5 p. c. Cum. Preferred	7½	6¼— 6¾	6¼— 6¾	...	...
30,364*l*	Do. do. do. 5 p. c. Deferred	7½	4 — 4½	4 — 4½	...	...
189,700*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	103 —106	103 —106	...	...
237,200*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 —106	103 —106	...	...
88,321	West India and Panama Telegraph, Limited	10	1½— 1¾	1½— 1¾	...	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	8¾— 9¼	8¾— 9¼	9⅛	9
4,669	Do. do. do. 6 p. c. 2nd Preference ...	10	7 — 8	7 — 8	...	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	118 —122	118 —122	...	...
173,100*l*	Do. do. 6 p. c. Sterling Bonds	100	98 —102	98 —102	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	6¼— 6¾	6¼— 6¾	...	...

* Subject to Founders' Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid) 7¼—7⅝.—Electric and General Investment, Shares of £5, £1 paid, 2¾—3¼.—European Sims-Edison Torpedo Company, shares of £20, fully paid, 20—20½.—Halifax and Bermuda Cable, 4½ per cent. bonds, 85—95.—House to House Company (£5 paid) 4½—5.—†Liverpool Electric Supply, Shares of £5, £3 paid, 2¾—2⅞. Shares of £5 (fully paid), 4⅞—5⅛.—London Electric Supply Corporation, Ordinary (£5 paid), 1—1½. Do. 6 per cent. Preference, 1¾—2¼.—Manchester, Edison and Swan Company, £9 (£1 paid), ½—⅝.—National Telephone Debentures, 2½—3 prem.—Woodhouse and Rawson Ordinary of £5 (£2 10s. paid), 2⅛—2⅜.— £5 Preference, fully paid 3⅝—3⅞.—Wards Electric Car, £10 paid, ¾—1.

† Quotations on Liverpool Stock Exchange.

BANK RATE OF DISCOUNT.—3½ per cent. (December 10th, 1891).

THE MEASUREMENT OF THE RESISTANCE OF CONDUCTORS CONTAINING DISTURBING E.M.F.'s.*

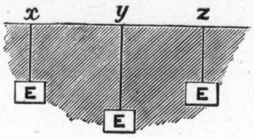
By ROLLO APPLEYARD.

THE principal practical case in which we have a conductor containing a disturbing E.M.F., is a telegraphic circuit terminating in earth-plates. These earth-plates, from various causes, act as a battery; and the resistance of the line appears too small or too great, depending on the direction of the natural currents with respect to the working current. In order that the position of a fault may be accurately found it is desirable to know the resistance of the earth-plates and the value of the natural E.M.F. As it was with earth-plates that my first experiments were made, I propose in this paper to give you the results obtained with them in full. For the sake of clearness it has been found necessary to refer to much that is elementary; in this I must ask for your kind indulgence.

Let us first be sure of what we mean by the resistance of an earth-plate. Taken alone, the term does not quite explain itself.

Schwendler ("Testing Instructions," Vol. II.) defines it as "the resistance offered by our planet between the earth-plate and another earth-plate of very great size, situated at a very great distance." It is there also shown that, if we accept this definition, we are justified in assuming the resistance between any two earth-plates as equal to the sum of their respective resistances.

FIG. 1.



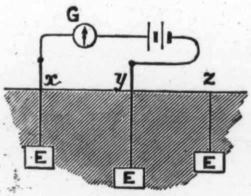


FIG. 2.

If then we are given three earth-plates of unknown resistances, x, y and z, it is possible by connecting them in pairs, to find their individual resistances. Let

$$x + y = a,$$
$$y + z = b,$$
$$z + x = c,$$

where a, b and c are the resistances of the plates taken in pairs and measured by any of the "earth-to-earth" systems. Then

$$x = \frac{a + b + c}{2} - b$$
$$y = \frac{a + b + c}{2} - c$$
$$z = \frac{a + b + c}{2} - a$$

The traditional method for the finding of a, b and c, is similar to the one adopted for measuring the resistance of cells by a tangent galvanometer. It has to be modified, however, to allow for the disturbing E.M.F. of the plates themselves. Let E be the E.M.F. of the testing cell, and B its internal resistance; G, the galvanometer resistance, and θ_0, θ_1, the deflexions corresponding to added resistances, R_0 and R_1. We have

$$E = \tan\theta_0 (G + B + R_0) \qquad (1)$$
$$E = \tan\theta_1 (G + B + R_1)$$

Hence $$G + B = \frac{R_1 \tan\theta_1 - R_0 \tan\theta_0}{\tan\theta_0 - \tan\theta_1}$$

Now, in place of R_0, R_1, put the leads from the earth-plates, x and y (fig. 2.). The disturbing E.M.F. is acting at first, suppose, in the same sense as E. Let it be e; then

$$E + e = \tan\theta_{11} (G + B + x + y) \qquad (2)$$

Now reverse the testing battery so that e opposes E; then

$$E - e = \tan\theta_{111} (G + B + x + y) \qquad (3)$$

From (2) and (3) we have

$$E = \frac{\tan\theta_{11} + \tan\theta_{111}}{2} (G + B + x + y) \qquad (4)$$

From (1) and (4)

$$x + y = \frac{\tan\theta_0 (G + B + R_0)}{\frac{\tan\theta_{11} + \tan\theta_{111}}{2}} - (G + B)$$

This gives us a. The values of b and c are similarly arrived at, and these results are said to give the earth-plate resistances.

A series of tests was made by this method with three "earths," of which x was the resistance of the gas-pipes at the place in question; y, an earth-plate to a lightning conductor, and z, a copper earth-plate of ordinary type. The following values for the individual resistances were obtained at different times within a few weeks.

TABLE I.

x	y	z
·83 ...	... 3·33 ...	... 24·85
–·2 ...	... 6·3 ...	... 22·7
–1·2 ...	... 4·3 ...	... 33·1
·3 ...	... 6·3 ...	... 21·2
·12 ...	... 4·98 ...	... 19·69
–2·4 ...	... 5·9 ...	... 23·4
0·05 ...	... 4·45 ...	... 23·15
–1·07 ...	... 5·01 ...	... 22·24
–·06 ...	... 4·77 ...	... 21·7
–·16 ...	... 4·34 ...	... 20·09

Schwendler's tangent galvanometer, as made for the Indian telegraphic department was employed, with two Minotto cells connected in parallel.

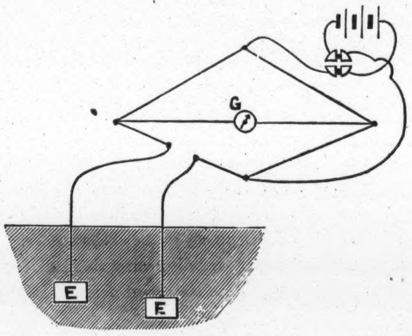


FIG. 3.

The absurdity of resistance with a negative sign should sufficiently show the fallacy of this method; and it will appear the more inconsistent when I refer you presently to results which make the resistances nearly constant throughout the same period of time. The variations are not due, as is generally assumed, to changes in the actual resistance of the plates themselves, but to the faulty method. We cannot take it for granted that the E.M.F's. remain unchanged when the circuits are once completed. e in equations (3) and (4) is not constant.

The second experiments were made with Wheatstone's bridge in its usual form (fig. 3). The difficulty was precisely the same. The E.M.F's. in the "unknown" arm of the bridge run themselves down through the other branches. The accuracy depends here, as before, upon e keeping constant.

The results were, if anything, rather worse than by the tangent galvanometer. The smallest resistance nearly always appearing with a negative sign. The wonder is that such methods still find a place in manuals on telegraphy. Schwendler's book suggests that these tests are best carried out on Sunday. The fact that mine were made on all days of the week may explain their inconsistency.

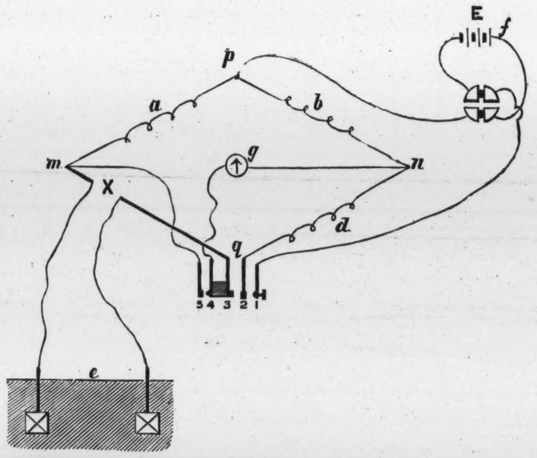


FIG. 4.

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* Read before the Old Students Association, December 16th, 1891.

If a nearer approach to accuracy was to be obtained it became evident that a means must be found for diminishing, as far as possible, the time during which the plates are on circuit at the bridge. The following method suggested itself:—

Let m, n, p, q represent the four corners of the bridge; a and b the ratio arms; d the variable resistance; and x the unknown resistance which contains the disturbing E.M.F. At q the meeting point of the battery branch with x and d, separate the three branches, and bring a connection from each to the upper three springs of a five-contact key. The lower springs, insulated from the three above, are for the completion of the galvanometer circuit. The conductor, whose resistance is to be determined is, at present, on open circuit. Now adjust the arm, d, to some assumed value of x, and verify it by a single tap of the key. The E.M.F. in the x branch cannot appreciably vary during that short interval, and by a few trials the correct value of d is determined. The testing battery is now reversed, and a new value, d^1, obtained for the variable arm. For general purposes it will be found sufficiently accurate to take the mean of d and d^1 as the required resistance of x. If the disturbing E.M.F., however, is high, we must use the whole formula for the resistance of the bridge arm and make the necessary correction. In this case let

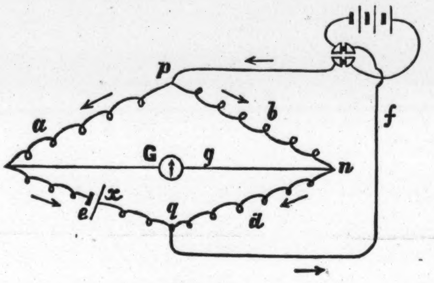


FIG. 5.

E = E.M.F. of testing battery.

e = E.M.F. in the x branch.

a, b, d, x, f, g = the resistances in the six branches.

$\mathrm{A, B, D, X, F, G}$ = the corresponding currents in a, b, d, x, f, g.

Then when $\mathrm{G} = 0$ there is the same difference of potentials between the ends of a as between the ends of b

$$\therefore \frac{\mathrm{A}}{\mathrm{B}} = \frac{b}{a} \qquad \mathrm{B} = \mathrm{A}\frac{a}{b} \tag{1}$$

$$\text{Considering point } m, \mathrm{X} = \mathrm{A} \tag{2}$$

$$\text{,, \quad ,,} \quad n, \mathrm{D} = \mathrm{B} \therefore \mathrm{D} = \mathrm{A}\frac{a}{b} \tag{3}$$

$$\text{,, \quad ,,} \quad p, \mathrm{F} = \mathrm{A} + \mathrm{B} \therefore \mathrm{F} = \mathrm{A}\frac{a+b}{b} \tag{4}$$

In the circuit, m, q, n, m, we have

$$e = \mathrm{X}\,x - \mathrm{D}\,d \therefore e = \mathrm{A}\left(x - \frac{a\,d}{b}\right) \tag{5}$$

In the circuit, q, p, n, q, we have

$$\mathrm{E} = \mathrm{F}f + \mathrm{B}\,b + \mathrm{D}\,d = \mathrm{A}\frac{a+b}{b}f + \mathrm{A}\frac{a}{b}b + \mathrm{A}\frac{a}{b}d$$

$$= \frac{\mathrm{A}}{b}\left([a+b]f + a\,b + a\,d\right) \tag{6}$$

From (5) and (6)

$$\frac{e}{\mathrm{E}} = \frac{b\,x - a\,d}{f(a+b) + a\,b + a\,d} \tag{7}$$

Now reverse the testing battery, obtaining $-\mathrm{E}$ for E, and d^1 for d

$$\frac{e}{\mathrm{E}} = \frac{-b\,x + a\,d^1}{f(a+b) + a\,b + a\,d^1} \tag{8}$$

Add numerators and denominators, respectively of (7) and (8),

$$\therefore \frac{e}{\mathrm{E}} = \frac{a(d^1 - d)}{2f(a+b) + 2\,a\,b + a(d^1 + d)} \tag{9}$$

Subtract ditto,

$$\frac{e}{\mathrm{E}} = \frac{2\,b\,x - a(d^1 + d)}{a(d - d^1)} \tag{10}$$

By equating (9) and (10) we have

$$x = \frac{a(d^1 + d)}{2\,b} - \frac{a^2(d^1 - d)^2}{2\,b\left(2f[a+b] + 2\,a\,b + a[d^1 + d]\right)}.$$

For practical purposes this complete formula need be applied only in extreme cases. Using the simple relation

$$x = \frac{d^1 + d}{2} \cdot \frac{a}{b}$$

the following values were obtained at different times for the resistances of the earth-plates before referred to:—

TABLE II.

Date.	x	y	z
3/6/91	·325	3·83	16·6
,,	·330	3·84	16·725
4/6/91	·320	3·945	17·325
,,	·348	3·768	17·263
5/6/91	·280	3·875	17·20
6/6/91	·290	3·845	17·545
9/6/91	·273	3·808	17·513

Between these tests the plates were used from time to time for signalling work and line testing. It is seen that their resistance varies but very little.

By the formula (9) we are able to find e, the disturbing E.M.F., in terms of E, the E.M.F. of the testing battery.

In this case the value of E was practically 1 volt. The table shows the values of e in the above experiments, calculated from (9), for different days.

TABLE III.

x	d	d_{2}^{1}	e	Date.
$x + y$	341	490	·034	3/6/91
$y + z$	1,195	2,890	·221	
$z + x$	2,577	807	·253	
$x + y$	344	489	·033	4/6/91
$y + z$	1,235	3,019	·227	
$z + x$	2,699	830	·262	
$x + y$	340	491	·034	5/6/91
$y + z$	1,241	2,974	·222	
$z + x$	2,655	842	·255	
$x + y$	336	491	·035	6/6;91
$y + z$	1,207	3,071	·237	
$z + x$	2,749	818	·269	
$x + y$	333	483	·034	9/6/91
$y + z$	1,244	3,020	·226	
$z + x$	2,715	842	·262	

The galvanometer employed was the same as that used in the previous experiments with the bridge; a long-coil Siemen's reflecting instrument of India service pattern. The key is made with broad surfaces of contact. The ordinary B.A. bridge key can be readily adapted to the purpose by the addition of an extra spring between the upper contacts.

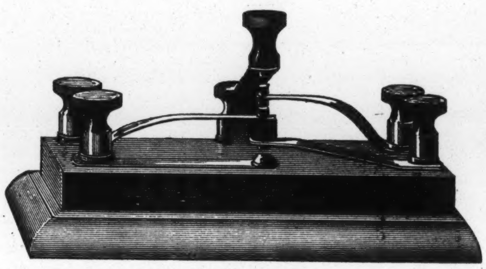
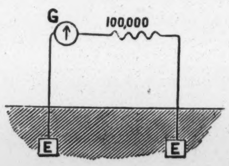


FIG. 6.

An inspection of Table III. shows fairly well that the E.M.F. of an earth-plate, and its resistance, does not vary appreciably within the limits of time required, by this method, to carry out a test We may call these values the "initial E.M.F.," and the "initial resistance" respectively. By the tangent galvanometer method the change in the E.M.F. is very considerable. In order to compare these an independent measure was taken, using a galvanometer of about 6,000 ohms resistance as a voltmeter. When connected through 100,000 ohms between the plates x and z, the change in E.M.F. was found to be *nil*. To reproduce the tangent galvanometer arrangement, the reflecting galvanometer was shunted so that its resistance was about equal to the tangent galvanometer, the 100,000 ohms being removed. The deflection, of course, diminished rapidly, losing about $\frac{1}{8}$th its initial value after 1 minute; $\frac{1}{4}$th its initial value after $2\frac{1}{2}$ minutes; $\frac{1}{3}$rd its initial value after 10 minutes.

FIG. 7.



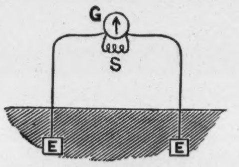


FIG. 8.

If we use the method of instantaneous taps with a sensitive galvanometer and a multiplying ratio, we can make a close examination of the plates at any time. When balance is very nearly obtained, we can watch the polarisation effects, if we please, by keeping the key down; we can also note how soon the polarisation effects vanish after the causes that produced them are removed; and how soon the "initial resistance" is regained.

For practical work with earth-plates we do not want to spend time in speculations of this kind. The galvanometer need not be very sensitive, nor the multiplying ratio very high. We want the truth, but not to the "fifth decimal.

It is otherwise, however, when there is an electrolytic resistance to be measured; or when using the method for comparing the E.M.Fs. of easily polarisable cells, by formula (9); or again, when, for very high resistances, a dividing ratio has to be used at the arms, *a*, *b*.

There is uncertainty with liquid resistances, arising from changes in density, composition, and purity, and a doubt also regarding the nature of contact between the liquid and the electrodes. I believe, however, that the method of taps will be found of great use in these determinations. If the nature of the conductor or electrolyte is such that the disturbing E.M.F. is variable, it is necessary to arrange the bridge so that d and d^1 may be obtained, as nearly as possible, simultaneously. For this purpose I have used two boxes of resistance coils in the variable arm, each provided with a short-circuiting plug, so that one can be cut out when the other is in. The resistance of one of the boxes is approximated to for two trial taps. This box is now plugged up and the second box unplugged, the testing battery being reversed. The second box is now adjusted as nearly as possible for two trial taps. This has to be repeated until d and d^1 are obtained.

If the electrolyte, or resistance under test, is very easily polarised, even by the instantaneous current, a difficulty appears in judging the right values of d and d^1 Consider what happens when the circuit is completed, the variable arm, d, being a little too much. When the key is depressed, and kept down, there will be a momentary deflection in the direction indicating "d too much," followed immediately by a motion in the reverse direction, making d apparently "too little," We can evidently find a value for d at which the first effect will just vanish. This is to be taken as the proper reading. It is important to observe that the same order of deflections occurs whatever be the direction of the testing battery. The secondary deflection which is, of course, due to polarisation in the x branch of the bridge, always acting in a direction indicating "d too little."

The explanation is simple. Referring to fig. 5, we see at once that it is E, and not e, which determines the directions of the currents in the various arms of the bridge. So that E, and not e, defines also the directions of the polarisation currents in the arm x. We may assume e, the initial E.M.F., to act as an added or subtracted resistance according to its direction with respect to E. Polarisation effects will always act in a direction indicating "d not enough" for opposing E.M.F's., are equivalent to added resistances. If, then, d is adjusted to the value corresponding to the initial resistance of x, any depression of the key, long enough to cause polarisation, will increase the apparent resistance of the unknown arm, and will make the variable arm "not enough." As long as d is greater than the value corresponding to the initial resistance of x, there will be, on depressing the key, a momentary deflection in the direction indicating "d too much," followed by the reverse deflection if the key is kept down long enough to cause the polarisation currents to start in the x arm. Consequently the only correct value for the variable arm is the value at which the first motion, indicating "d too much," just vanishes.

Now, I want to put before you the difficult combination of an inductive resistance in circuit with a polarisable one. This arose on one occasion when a line test was being made; the relay at the distant station had considerable inductance, being magnetically polarised, and the earth-plates had polarisation of the kind represented by another meaning of that ill-used term. If the tap was made very suddenly, there was a sudden deflexion arising from the inductance at the relay. It was scarcely to be mistaken for an electrolytic polarisation effect, being more rapid than those which earth-plates generally produce. The obvious way of removing the difficulties is to tap deliberately rather than suddenly. It may be well to observe that with an ordinary Wheatstone's bridge, with the best of B.A. keys, the key does not remove the effects of inductance for very sudden taps. At the present price of platinum, another factor comes in here also, the wear and tear of contacts, caused by taps too sudden and energetic.

Applying the detaching principle to the differential galvanometer, we obtain an alternative method, which it is possible might be of service in a special case. Fig, 9 shows the way in which the three branch circuits are separated out. In this instance a key with three contacts would be employed. Here we are not dealing with steady currents through the galvanometer, and consequently, only approximate results are to be expected, unless we can insure that each coil of the galvanometer, together with its shunt, has the same induction coefficient. As this will seldom be the case, I suggest the device simply for what it is worth. The complete formula may be arrived at as follows:—

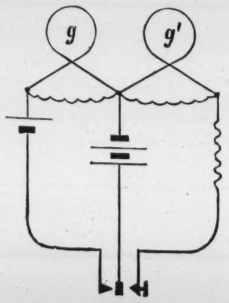


FIG 9.

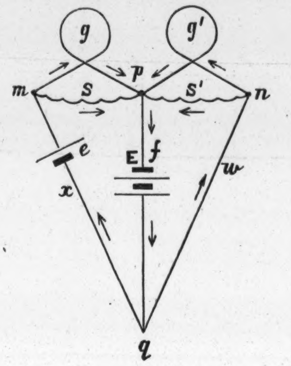


FIG. 10.

Let E = E.M.F. of testing battery; f, its resistance; e = E.M.F. in the arm, x.

Denote the resistances of the various branches by small letters, and the corresponding currents by capitals.

We have,

$$\mathrm{G}\,g = \mathrm{S}\,s \quad (1); \qquad \mathrm{X} = \mathrm{S} + \mathrm{G} \qquad (3)$$

$$\mathrm{G}'g' = \mathrm{S}'s' \quad (2); \qquad \mathrm{W} = \mathrm{S}' + \mathrm{G}' \qquad (4)$$

$$\mathrm{F} = \mathrm{X} + \mathrm{W} \qquad (5)$$

In ordinary differential galvanometers, $g = g'$ (6)

When balance is obtained $\mathrm{G} = \mathrm{G}'$ (7)

$$\therefore\ \mathrm{G}\,g = \mathrm{G}'\,g' \qquad (8)$$

From (1) and (2), $\mathrm{S}\,s = \mathrm{S}'\,s'$ (9)

In the circuit m, n, q, m,

$$e = \mathrm{X}\,x + \mathrm{S}\,s - \mathrm{S}'\,s' - \mathrm{W}\,\omega$$

From (9)

$$e = \mathrm{X}\,x - \mathrm{W}\,\omega \qquad (10)$$

From (2),

$$\frac{\mathrm{G}'}{\mathrm{S}'} = \frac{s'}{g'}\ \therefore\ \frac{\mathrm{S}' + \mathrm{G}'}{\mathrm{S}'} = \frac{s' + g'}{g'}$$

$\therefore$ From (4)

$$\frac{\mathrm{W}}{\mathrm{S}'} = \frac{s' + g'}{g'}.\ \text{Or } \mathrm{S}' = \mathrm{W}\,\frac{g'}{s' + g'} \qquad (11)$$

In the circuit p, n, q, p,

$$\mathrm{E} = \mathrm{F}\,f + \mathrm{W}\,\omega + \mathrm{S}'\,s'$$

$\therefore$ From (5) and (11)

$$\mathrm{E} = \mathrm{X}\,f + \mathrm{W}\,f + \mathrm{W}\,\omega + \mathrm{W}\,\frac{s'\,g'}{\mathrm{S}' + g'} \qquad (12)$$

From (1)

$$\frac{\mathrm{S}}{\mathrm{G}} = \frac{g}{s},\ \therefore\ \frac{\mathrm{S} + \mathrm{G}}{\mathrm{G}} = \frac{s + g}{g},\ \therefore, \text{from (3)},\ \frac{\mathrm{X}}{\mathrm{G}} = \frac{s + g}{g} \qquad (13)$$

Similarly,

$$\frac{\mathrm{W}}{\mathrm{G}'} = \frac{s' + g'}{g} \qquad (14)$$

From (7), (13), and (14),

$$\frac{\mathrm{W}}{\mathrm{X}} = \frac{\dfrac{s' + g'}{g'}}{\dfrac{s + g}{g}} = k \qquad (15)$$

$$\therefore\ \mathrm{W} = \mathrm{X}\,k \qquad (16)$$

(10) may now be written,

$$e = \mathrm{X}\,x - \mathrm{X}\,k\,\omega \qquad (17)$$

and (12) becomes

$$\mathrm{E} = \mathrm{X}\,f + \mathrm{X}\,k\,f + \mathrm{X}\,k\,\omega + \mathrm{X}\,k\,\frac{s'\,g'}{s' + g'} \qquad (18)$$

$$\therefore\ \frac{e}{\mathrm{E}} = \frac{x - k\,\omega}{f + k\,f + k\,\omega + k\,\dfrac{s'\,g'}{s' + g'}} \qquad (19)$$

Reverse the testing battery, obtaining ω' for ω, and $-$ E for E.

$$\therefore\ \frac{e}{\mathrm{E}} = \frac{k\,\omega' - x}{f + k\,f + k\,\omega' + k\,\dfrac{s'\,g'}{s' + g'}} \qquad (20)$$

Add numerators and denominators, respectively, of (19) and (20).

$$\frac{e}{\mathrm{E}} = \frac{k\,(\omega' - \omega)}{2\,f + 2\,k\,f + k\,(\omega' + \omega) + 2\,k\,\dfrac{s'\,g'}{s' + g'}} \qquad (21)$$

Subtract ditto.

$$\frac{e}{\mathrm{E}} = \frac{2\,x - k\,(\omega' + \omega)}{k\,(\omega - \omega')}$$

Or,

$$\frac{e}{\mathrm{E}} = \frac{k\,(\omega' + \omega) - 2\,x}{k\,(\omega' - \omega)} \qquad (22)$$

Equating (21) and (22), we have,

$$x = k \cdot \frac{\omega' + \omega}{2} - \frac{k^2(\omega' - \omega)^2}{2\left[2f + 2kf + k(\omega' + \omega) + 2k\frac{s'g'}{s' + g'}\right]}$$

In England the earth-plate is scarce. You will inquire for them in vain at the G P.O. in Aldersgate Street. The gas and water companies, in a truly generous spirit, provide us, in the pipes which they lay at our feet, with a substitute excellent in efficiency, and, what is perhaps more important, costless to maintain, at least from our point of view.

But abroad, as in India or Persia, their importance is extremely great, and the earth-plate test is a regular part of the telegraphist's routine.

It has been suggested that a series of careful tests of the resistance of plates of the same dimensions, and planted in the same way, at fixed depths and distances, in strata of different geological character, would be of service in indicating the nature of the intervening rock. And it would appear that some such method as this offers the only means of investigating the direction and duration of earth-currents proper, of which, at present, scarcely anything definite is known.

This principle of separating out the arms of the bridge at the junction of two of them, by a key, so as to prevent the short-circuiting of the resistance under test during the adjustment of the variable arm, would appear to be applicable whatever form the bridge may take.

By its means the method of Mance, which has hitherto been considered impracticable, is rendered at least probable as to the value of results obtained. In this way, also, a possible objection to the "rocker" device of Ewing and Macgregor would be removed.

The employment by Kohlrausch of an alternating current with the Wheatstone's bridge has given results so admirable as scarcely to admit of improvement. A means for keeping the electrolyte on open circuit, except during the moments of trial, would seem of advantage, however, even in his most excellent method.

LEGAL.

John Denby v. Ernest Scott and Mountain.—In the Court of Session, Edinburgh, last week, Lord Kyllachy gave judgment in the action by John Denby, stereotyper and electrotyper, 4, Swinton Row, Edinburgh, against Ernest Scott and Mountain, engineers, Close Works, Newcastle. Pursuer sued for £500. The defenders, he said, supplied him with a dynamo for electrotyping purposes which did not work satisfactorily, depositing the copper in granular form, and he claimed damages in respect that the defenders had not fulfilled their contract to provide him with a proper machine. The defenders contended that the machine with which they supplied the pursuer was capable of doing the work the pursuer intended it for, but that he did not fit it up properly, nor work it skilfully.

Lord KYLLACHY said he did not feel altogether sure about the decision in this case. Long as the proof had been, it had not quite cleared up the mystery which he thought still surrounded the history of this dynamo. His Lordship had, however, after carefully reading the correspondence and the evidence, come to the conclusion that he must find for the defenders, on the ground that the pursuer had not proved that the dynamo in question was disconform to contract. He did not propose to state his views on the evidence in detail, but he might give some of the points on which he had formed his opinion. In the first place, his Lordship was disposed to accept the pursuer's reading of the contract, viz., that the defenders undertook not merely to supply a dynamo answering the description of No. 5, Class 6, but they also guaranteed that the machine furnished was suitable for electrotyping, and would, under proper conditions, and worked by the pursuer's gas engine, particulars of which were given, produce a satisfactory deposit of copper. He did not think, indeed, that this was seriously disputed by the defenders. At any rate, his Lordship had little doubt that their undertaking went thus far. In the second place he thought it was equally clear that the dynamo which the pursuer furnished did not, when supplied to the pursuer's works, and tried practically over a period of some months, give satisfactory results. On the contrary it was, his Lordship thought, clear that the results were hopelessly bad, and that the pursuer, after trying everything he knew, and everything the defenders suggested, was unable to effect any improvement, the result being that his business, if not destroyed, was greatly injured, and he suffered in various ways serious loss and damage. Now, as to the cause or causes of this failure, the direct and positive evidence was not at all satisfactory. He could not say that the defenders had succeeded in establishing any definite fault as against the pursuer's bath, or the solution, or his manipulation of his bath. So far as appeared, the pursuer worked throughout in the same manner as he had successfully worked his battery, and experienced electrotypers, such as Mr. Clyde, whom he called in, found nothing wrong with his methods, and the defenders, in their correspondence, suggested nothing wrong. Their complaint was that the pursuer expected quicker work with the dynamo than with the battery, an expectation which, according to Mr. Fairfoul, was entirely right. Mr. Lowes said he suggested that pursuer had too weak a solution, but he did not mention this in his correspondence with his principals, and nobody suggested the main complaint, the granulated character of the deposit. It was true, also, that one of the defenders' witnesses, Mr. Fairfoul, condemned the use of acid in the solution when a dynamo was being used, and the whole difficulty might have been due to that cause, but all the other witnesses approved of the use of acid, although some of them appeared to hold that with a dynamo less acid should be used than with a battery. Altogether his Lordship was bound to say that the defenders, if the onus rested on them, had not, in his opinion, succeeded in explaining the admitted failure of the results by anything to which they could point connected with the pursuer's bath or of his methods of manipulation. It remained, however, to consider whether the pursuer, on whom the onus primarily lay, had been able to prove affirmatively that there was something wrong with the defenders' dynamo. It was not enough for the defenders to say that there was no proof of anything wrong with the bath. The fault might have been there, although no particular fault could be proved. The pursuer must, in order to succeed, show that there was something wrong with the dynamo. Now his Lordship was bound to say that apart from the proved results of the recent trials of the machine in Mr. Goskirk's and Messrs. Chambers's works he should have been on the whole inclined to hold that the balance of the evidence was against the suitableness of this dynamo for purposes of electrotyping. He meant that apart from the trials referred to, he should have been inclined to conclude that this dynamo was of too high a voltage or electromotive force for electrotyping, and that for some reason it did not admit of having its voltage reduced by the usual expedients, or reduced so as to give a good result. But then these recent trials, if they were to be trusted, appeared to demonstrate that the voltage was not too high, but quite suitable, and that this identical dynamo worked in connection with ordinary baths and under ordinary conditions had repeatedly produced electrotypes to which no fault could be found, and which, indeed, were admitted ta be of exceptional excellence. The evidence of Mr. Fairfoul, Mr. Mackay, and Mr. Goskirk, all seemed to establish that beyond doubt. Unless, therefore, there was some reason to believe that the dynamo as it now stood had been in some way altered, and was not now in the same condition as it was when it left the pursuer's works, his Lordship had not been able to see any escape from the conclusion that whatever might have been wrong with the pursuer's results, the fault was not in the dynamo; and that being so, the question was brought to this—was he to believe or disbelieve the defender's evidence on this subject. His Lordship confessed when it was so put that he hesitated to come to the conclusion that contrary to the testimony of Mr. Mountain, concurred in by Mr. Rolfe, and not impugned or contradicted by any direct evidence to the contrary, the defenders were guilty, for the purpose of defeating the pursuer's claim, of a gross and deliberate fraud; that was to say, that they altered previous to the trials in Edinburgh the armature or other parts of the machine. It was no doubt unfortunate that the machine, having been returned to the defender's works—he thought in April—remained at these works in Newcastle until September, when it was again sent down to Edinburgh to be tried at Mr. Goskirk's works; but his Lordship could not say that that was, in his opinion, sufficient, as the pursuer suggested, to deprive the recent trials in Edinburgh of all value. His Lordship thought, difficult as the whole case was, that it was, on the whole, more probable that there was something wrong with the pursuer's management of his bath or management of his gas engine, than that the dynamo, which worked so well now, was a different machine from that supplied to and worked by the pursuer. On the whole, therefore, he had come to the conclusion that the pursuer had failed to prove his case, and that the defenders must be assoilzied with expenses.

Brunton v. The Electrical Engineering Corporation, Limited.—This case, which came before Mr. Justice Kekewich on Saturday last, raised a novel question on the form of debenture now usually adopted by joint stock companies. In the action, which was a debenture holder's action, Mr. H. S. Holt, the solicitor to the company, applied for a declaration that he had, before and at the date of an order made in the action on the 8th of June last appointing a receiver and directing all documents in his (Mr. Holt's) possession to be handed over to the receiver, a lien upon these documents. The company was formed in January, 1890, being an amalgamation of two then existing companies. Upon the completion of the amalgamation Mr. Holt proceeded to act as the solicitor of the new company, and at the date of the commencement of the present action they were indebted to him, as their solicitor, in a sum of about £220. At the date of the order appointing the receiver, a large number of documents belonging to the company were in Mr. Holt's possession as their solicitor. In April last the company passed resolutions for a voluntary winding up, which was continued under supervision by an order made in May last. The question was whether Mr. Holt's lien should rank in priority to the charge of the debenture holders. By the form of the debentures they were to rank *pari passu* as a "first charge" on the company's undertaking and property, "and the charge hereby created is to be a floating security, but so that the corporation is not to be at liberty to create any mortgage or charge in priority to the said debentures."

Mr. Renshaw, Q.C., and Mr. Bramwell Davis appeared for Mr. Holt; and Mr. Warmington, Q.C., and Mr. Swinfen Eady for the debenture-holders.

Mr. Justice KEKEWICH said this case raised a neat and novel question. Given a "floating security"—that is, a security of a description familiar to the Court and to gentlemen conversant with company business—was it competent to the company which created that security to employ a solicitor so as to allow him to have that general lien which, according to law, a solicitor had upon the documents of his clients in his possession? That was the question his Lordship had now to consider. That a company was allowed to employ a solicitor went without saying. The first question was, What was a "floating security?" His Lordship should hesitate to attempt to define the term, because definitions were sometimes dangerous; but fortunately he already had a definition in other cases, to which he referred, namely:—"In *re* Florence Land and Public Works Company," judgment given by the late Master of the Rolls; "Wheatley *v.* Silkstone and Haigh Moor Coal Company," judgment given by Mr. Justice North. Also the case of "Pelly *v.* Wathen" showed what a solicitor's lien was. "The general lien of solicitor," said Lord Cranworth, "was merely a right to keep back from his client the deeds and papers which he holds as solicitor until his bill of costs is satisfied." Having regard to that view of the position of a solicitor and his client, was there anything to prevent a company from employing a solicitor and giving him his proper right? His Lordship was clearly of opinion that there was not. The debenture-holders had no right to interfere with the use by the company of their property in the ordinary course of their business, and could do nothing to prevent the company from making away with their property, and so leaving nothing for the debenture-holders. The company were masters of their own position, and there was nothing to prevent their solicitor acquiring that right which the general law gave him. Now, looking at this form of debenture, was the lien now claimed a "mortgage or charge?" His Lordship did not think it was. It was a lien which the general law gave the solicitor. It was difficult to state what a solicitor's lien was in accurate language. It had been said that it was a right to sit upon the documents; he could only lock them up, and say to his client, "You shall not have them until you have paid my costs." Looking at the clause here, his Lordship thought the words "mortgate or charge" did not include a lien of this kind. Supposing this lien was a "mortgage or charge," was it a "mortgage or charge created by the company?" His Lordship thought not. The words pointed to something done by the company, creating by their own act an encumbrance on the property which, but for this provision, would take priority of the debentures. His Lordship did not think they applied to a charge or lien given by the general law, and arising by the company carrying on its business in the ordinary course. If there was the slightest attempt on the part of the company to do anything themselves by way of creating a priority over the debenture holders, that might fall within the particular words; but while the company were acting according to the ordinary course of business and merely allowing their solicitor, also acting in the ordinary course of business, to acquire a lien which the general law gave him, in his Lordship's opinion they were not creating a "mortgage or charge." Accordingly, his Lordship must hold that the solicitor's lien was left untouched by the debenture holders taking possession, as they had done by the appointment of a receiver. Up to that date the employment by the company of their solicitor gave him his ordinary rights, and those rights were not taken away by anything done subsequently.

The Edison and Swan United Electric Light Company, Limited, and the Edison Electric Light Company, Limited v. Hamilton and another.—In the Chancery Division on Saturday, Mr. Justice Mathew, sitting for Mr. Justice Stirling, had before him the case of the Edison and Swan United Electric Light Company *v.* Hamilton and Roxburgh, which was an action brought by the plaintiffs to restrain the defendants, who carry on business at 4B, Newland Terrace, Kensington, from infringing their patents for electric lamps, and to recover damages. The defendants, who had filed a defence denying the alleged infringement, did not appear either in person or by counsel.

Mr. Bremner, who appeared for the plaintiffs, said the patents which his clients alleged the defendants had infringed gave them (the plaintiffs) a monopoly of the electric lamp similar to that used in the Royal Courts of Justice. There were two patents involved—the Edison and the Cheesbrough—and both had been upheld by the Court of Appeal.

Mr. Justice Mathew inquired whether the question to be decided was as to the validity of the patents.

Mr. Bremner said the sole question for his lordship was as to the alleged infringement. The validity of the patents had already been upheld in the Court of Appeal. The defendants by their pleadings had not raised the question of the validity of the patents.

Mr. J. M. Moffatt, engineer in the employ of the plaintiffs, stated that on May 4th he purchased four electric incandescent lamps at the defendants' shop, and that on June 3rd he purchased 20 more. He handed the lamps to Mr. Gover, plaintiffs' assistant secretary.

Mr. H. C. Gover, assistant secretary to the plaintiff company, gave evidence to the effect that he handed the lamps which he received from the last witness to Dr. Fleming for examination.

Mr. J. A. Fleming, Doctor of Science, stated that for 14 or 15 years he had devoted great attention to electric lighting. He received certain lamps from Mr. Gover, and he examined them. They were composed of a glass reservoir from which the air had been exhausted, and through the walls of the glass reservoir platinum leading wires were sealed in, and to the ends of these wires were attached as filaments, which he proved to be carbon. In his opinion, the lamps in question infringed Edison's patents, with which he was well acquainted. The Cheesbrough patent had reference to a special process for treating the filaments, and the filaments of the lamps he examined had been treated according to that process. The lamps had not been manufactured by the Edison Company.

Mr. Justice Mathew thought that the plaintiffs had called sufficient evidence to justify him in granting an injunction restraining the defendants from making any more of such lamps.

Mr. Bremner said he also asked for an order directing the defendants to deliver up all lamps which infringed the plaintiffs' patents.

Mr. Justice Mathew remarked that the plaintiffs were entitled to such an order, in addition to the injunction.

Mr. Bremner: And under section 29 of the Patents Acts we are entitled to a certificate that we have proved our breaches.

Mr. Justice Mathew: Yes.

Mr. Bremner: The validity of the patents having been previously upheld, I ask for costs as between solicitor and client.

Mr. Justice Mathew: I don't think I can do that.

Mr. Bremner: The statute states that I shall have my full costs.

Mr. Justice Mathew; I do not order them, but if the statute gives them to you well and good.

Injunction granted accordingly with costs.

NEW PATENTS—1891.

20,807. "An automatic electric disc vote recording and counting machine" W. Hearn and W. F. Lewis. Dated November 30th.

20,814. "Simultaneous telegraphy and telephony." J. M. Richards and J. Stephen. Dated November 30th.

20,825. "Improvements in the insulation or covering of or for electrical cables." H. Edmunds and G. E. Preece. Dated November 30th.

20,827. "Improvements in electric lighting attachments for gas burners." D. J. Quinn and P. W. Hoffmann. Dated November 30th.

20,830. "Improvements in electric safety lamps for mining and other purposes." E. Bohm and E. Bailey. Dated November 30th.

20,837. "Extracting gold and silver from sea water by electrolysis." C. H. Woolf, A. E. Hayman and A. D. R. Jameson. Dated November 30th.

20,840. "Improvements in armatures of dynamo-electric machines." J. Nebel. Dated November 30th. (*Complete.*)

20,864. "A new or improved combined electro-medical apparatus coil and battery." T. C. Hodgkinson and H. T. Tompsitt. Dated November 30th. (*Complete.*)

20,865. "An improved electric railway system." A. J. Eli. (Communicated by J. S. Zerbe, United States.) Dated November 30th.

20,886. "Improvements in or connected with electric masthead and side lights for ships." W. C. Martin and J. Hunter. Dated December 1st.

20,900. "Improvements in arc electric lamps." W. Macpherson. Dated December 1st.

20,913. "Improvements in electrically-propelled vehicles." M. W. Dewey. Dated December 1st. (*Complete.*)

20,922. "Improvements in storage batteries or accumulators." C. Lutcke. Dated December 1st.

20,924. "Improvements in and relating to electric fire engines." M. W. Dewey. Dated December 1st. (*Complete.*)

20,930. "Improvements in electrically-propelled vehicles." M. W. Dewey. Dated December 1st. (*Complete.*)

20,933. "Improvements in and relating to electrically-propelled hose carts or carriages." M. W. Dewey. Dated December 1st. (*Complete.*)

20,936. "Improvements in electric heating apparatus." M. W. Dewey. Dated December 1st. (*Complete.*)

20,969. "Improvements in electrolytic tanks." T. J. Holland. Dated December 1st.

20,970. "Improvements in apparatus for measuring and registering electric currents." J. W. T. Cadett. Dated December 1st.

20,972. "Improvements in combined haulage and electric cables." G. J. May. Dated December 1st.

21,015. "Improvements in oil or hydrocarbon motors." J. E Weyman, G. Hitchcock and J. A. Drake. Dated December 2nd.

21,018. "Improvements in the construction of electrically controlled arc lamps." F. T. Schmidt. Dated December 2nd.

21,028 "An improved gas or electric light appliance attached t a stud for the purpose of illuminating a dress shirt front." W Walton and E. Lester. Dated December 2nd.

21,033. "Improvements in dynamo machines." L. Pyke and E S. Harris. Dated December 2nd.

21,034. "Improvements in musical instruments operated by electricity." P. E. Singer. Dated December 2nd.

21,071. "The combined true magnetic or compass course pointe 'and' station pointer." J. Cleary. Dated December 3rd.

21,142. "Improvements in ceiling roses for electrical fittings." W. P. Adams. Dated December 4th.

21,143. "Improvements in electrical cut-outs." W. P. Adam Dated December 4th.

21,154. "Improvements relating to electrical lamp holders." C. S. Snell and Woodhouse and Rawson United, Limited. Dat December 4th.

21,173. "Means and electrical apparatus for promoting th growth of bulbs and other plants." R. H. Courtenay. Date December 4th.

21,187. "Improvements in regulating steam engines workin dynamo-electric machines and apparatus for that purpose." P. V McMahon. Dated December 4th.

21,207. "An improved electromotor." T. Sturgeon. Date December 4th.

21,211. "An improved electric call system and apparatus for us in connection therewith." W. H. Blakeney. Dated December 4t

21,214. "Improvements in meters or recorders of electricity." A. J. Boult. (Communicated by C. Lebois, ————.) Dat December 4th.

21,245. "Certain improvements in electric alarm and call clocks." J. L. CLERC, J. PICARD and I. ROUGEANT. Dated December 5th. (*Complete.*)

21,246. "Improvements in compound winding of groups of dynamos." J. M. M. MUNRO. Dated December 5th.

21,250. "Improvements in phonographs." S. FRANK and L. ROSENTHAL. Dated December 5th.

21,259. "Improvements connected with cash tills and means for electrically indicating each opening of same as a check to the receipts." A. SAMUEL, E. SAMUEL, T. FURSE and F. SIMMONDS. Dated December 5th.

21,263. "A magnetic lock principally applicable to doors, gates, boxes and drawers." H. V. SMITH. Dated December 5th.

21,265. "A new or improved coin-freed device for operating electric circuits." H. H. BROWN, A. ELLIOT and CHETHAM-STRODE, LIMITED. Dated December 5th. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1890.

13,570. "Improvements in and relating to telegraphic apparatus." B. EGGER. Dated August 28th. 8d. Claims:—1. In telegraphic apparatus the shunting in of electro-magnets in connection with a contact-making arrangement by means of which the current from the electrical battery continues to flow until both armatures, *i.e.*, those of the transmitting and receiving stations have accomplished a complete movement, or have moved so far as to cause the circuit to be broken, so as to effect a regular and uninterrupted action of the apparatus. 2. Notched wheels arranged on the shaft of an escapement wheel, together with a roller running on the said wheels, for the purpose of bringing the points of a crown wheel into close and proper contact with the teeth of an anchor, in order to render a regular movement of the indices in both apparatus more certain. 3. In telegraphic apparatus a system of connections as shown and described with reference to the drawings.

14,992. "Improvements in the construction of underground conduits for electrical conductors." W. C. C. HAWTAYNE. Dated September 23. 4d. The inventor arranges the tubes or ways (through which the conductors are to pass) in position in trenches made for their reception, and he supports them in position by distance pieces or in any convenient way. He then introduces into the trench cement, bitumen (or other material which will "set") so that it encloses the tubes or ways, and when set forms a continuous conduit without joints, and effectually protecting the tubes or ways. 1 claim.

16,055. "Improvements in electric batteries." H. G. C. SERRIN. Dated October 9th. 8d. Relates to a circulating battery arranged so as to obtain a large surface of contact with the depolarising liquid, and also a large surface of contact with the exciting liquid. Consists in arranging in the interior of each element one or more tubes for enabling the level to be established, and into these tubes is introduced any suitable syphon, serving either for the inlet or for the outlet of these liquids. 5 claims.

16,057. "Improvements in pillars and electroliers or pendants for electric lamps." R. B. EVERED and T. RUDLING. Dated October 9th. 8d. Claims:—1. In a standard, pillar, or pendant for an electric lamp, the combination of two tubes, one of which is provided internally with longitudinal insulating conducting strips and the other with contact springs adapted to press against the said contact strips, and one of which is fitted to slide longitudinally in the other, but is restrained from rotation therein, for the purpose specified. 2. A standard, pillar, or pendant, having improvements applied thereto, substantially as described with reference to the drawing.

16,156. "Improvements in electric conductors for carrying currents of electric matter." J. JOHNSTONE. Dated October 11th. 8d. Relates to improvements in the Ferranti plan of electric conductors, and chiefly consists in constructing the outer conductor of electricity of two metal tubes, an inner and an outer tube, with an air space between them. 4 claims.

17,402. "Improvements in and connected with electrical conductors and fittings combined therewith." D. COOK, C. R. G. SMYTHE, and E. PAYNE. Dated October 31st. 8d. Consists of an arrangement of metal tubes with an insulation placed one inside the other to form an electric circuit. 4 claims.

CORRESPONDENCE.

School Lighting.

We notice that a discussion has arisen with reference to a statement made in the press to the effect that the installation which we put down at Felstead School was considered to be the first instance of school lighting.

We wish to point that this account of the work did not emanate from us, nor are the statements correct with reference to England alone, as some years back we put the electric light into one of the leading houses at Harrow Schools.

As far as we know the first school in England lit by electricity was that of Mr. Sneyd Kynnersley, Ascot, which Mr. Drake arranged when engineer to the Brush Midland Company in the early days of electric lighting.

Drake & Gorham.

December 12th, 1891.

Electrical Conductors.

With reference to your note, headed "Minimum Diameter of Conductors," and giving a table of conductors, the diameters of which correspond to the maximum number of ampères which the circuits can carry with safety. On working out the table to ascertain the pounds of copper per statute mile per ampère, I find the following to be the results :—

B.W.G.	Ampères.	Diam.	lbs. per stat.	lbs. per ampère.
16	5	·065	67	13·4
14	10	·083	109	10·9
12	15	·109	188	12·5
10	20	·134	285	14·25
9	30	·148	348	11·6
8	35	·165	432	12·3
7	45	·180	514	11·4
6	50	·203	654	13·1
5	60	·220	768	12·8
4	65	·238	900	13·8
3	75	·259	1,065	14·2
2	85	·284	1,280	15·1
1	95	·300	1,430	15·1
0	110	·340	1,835	16·7
00	130	·380	2,292	17·6
000	159	·425	2,867	19·1
0000	175	·454	3,272	18·7

It would be interesting to know the rule upon which the above is based, as the variation is too great to be taken as a standard table.

Jno. P. Hooper.

December 11th, 1891.

Effect of Incandescent Lamps on the Eyesight.

May I be allowed space for a few lines, *re* one of your leading articles in last week's issue, entitled "Effect of Incandescent Lamps on the Eyesight."

You do not make any distinction between the effect produced by a filament brought to incandescence by a direct, or an alternating current. In my opinion this makes all the difference. The effect produced by looking for some time at a filament in a state of incandescence by the action of a direct current may, if the filament is not properly shaded cause some distress to people with weak eyes, but with a properly shaded lamp it is not conceivable that the electric light produced by a direct current should affect the eyes more than any other illuminant of the same intensity.

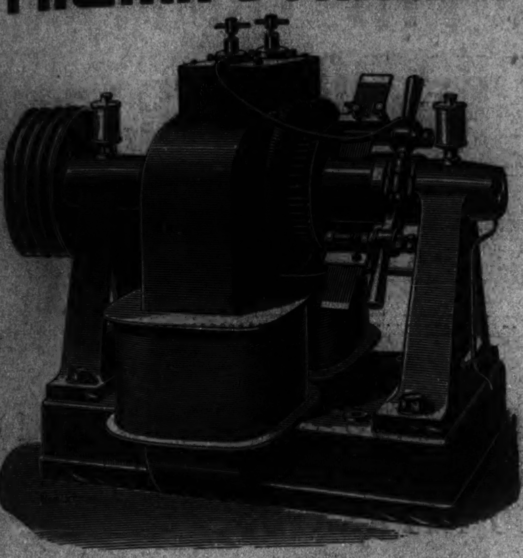
But a filament brought to incandescence by the action of an alternating current is another matter, and that such a lamp, more especially when the frequency of the alternator is low, does have an injurious effect on the retina of the eye, although the alternations may not be visible save for a certain twitching in the light, is a fact which is borne out by experience and cannot be gainsaid. Such a lamp, if not shaded or frosted sufficiently, will in time play havoc with the eyes of a person constantly working by it. I know of a case, and by no means an isolated one, of a billiard marker who was obliged to give up his work in consequence of this. When the alternations are more frequent the effect is not so marked.

I think therefore that where frosted lamps are not used on alternating circuits of low frequency, special precautions ought to be taken as to shading the filament, as if this is not done the high tension system may come into disfavour with the public for this very sufficient reason.

L. Maxwell Waterhouse, A.I.E.E.

December 15th, 1891.

PHŒNIX DYNAMOS



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WRITE FOR PRICE LISTS 203

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"S" TYPE. MODERATE SPEED.

Size.	OUTPUT IN WATTS.	Difference of Potentials in Volts.	No. of 60 Watt Lamps.	Approx. Speed.	Approx. Horse Power.	PRICE.	Extra for Bedding Rails and Tightening Screws.		Extra for Fly Wheel for Gas Engine.	
						£	£	s.	£	s.
1 S	600	30 to 60	10	1,800	1	20	1	10	2	0
2 S	900	40 to 70	15	1,750	1½	24	2	0	2	10
3 S	1,200	50 to 80	20	1,700	2	28	2	10	3	0
4 S	2,100	50 to 110	35	1,600	3½	33	3	0	3	10
5 S	3,000	60 to 110	50	1,520	5	44	3	5	4	0
6 S	4,500	60 to 110	75	1,430	7½	55	3	15	4	10
7 S	6,000	60 to 120	100	1,360	10	65	4	5	5	0
8 S	9,000	60 to 120	150	1,260	15	85	5	0	5	10
9 S	12,000	60 to 120	200	1,180	20	105	6	0	6	0
9½S	15,000	80 to 150	250	1,100	25	120	7	0	—	
10 S	18,000	80 to 150	300	1,020	30	135	8	0	—	
10½S	21,000	80 to 180	350	1,000	35	155	9	0	—	
11 S	24,000	80 to 180	400	900	40	175	10	0	—	
12 S	30,000	100 to 200	500	800	50	200	12	0	—	

These prices refer to Compound, Series or Shunt Machines wound to a difference of potentials between the limits given. For those of higher or lower potentials, an additional charge will be made and special quotations submitted.

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"D" TYPE. SLOW SPEED.

Size.	OUTPUT IN WATTS.	Difference of Potentials in Volts.	No. of 60 Watt Lamps.	Approx. Speed.	Approx. Horse Power.	PRICE.	Extra for Bedding Rails.	
						£	£	s.
6D	9,000	65 to 110	150	750	15	110	6	0
7D	12,000	65 to 110	200	700	20	130	7	0
8D	18,000	65 to 110	300	650	30	170	8	0
9D	24,000	65 to 110	400	600	40	220	10	0
10D	36,000	110 to 125	600	500	60	290	12	0
11D	48,000	110 to 125	800	450	80	375	14	0
12D	60,000	110 to 125	1,000	400	100	450	16	0

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